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MOSQUITO CULTURE TECHNIQUE

HELEN LOUISE TREMBLEY, Assistant Entomologist, Division of Physiology, National Institute of Health, U. S. Public Health Service, Bethesda, Maryland

The rearing of mosquitoes in captivity is being carried on to a greater extent now than in previous years. Research on such mosquito-borne diseases as malaria, dengue, yellow fever, filariasis, and equine encephalomyelitis has involved the use of laboratory-reared insects for some years. Furthermore, mosquitoes have been used for a long time in control investigations and in the transmission of malaria for the treatment of paretics. Now, however, a more widespead interest and need is manifesting itself. Global war has stimulated investigations on repellents and insecticides, and has intensified research on certain of the mosquito-borne diseases and their treatment. In this country, studies on poliomyelitis and its possible vectors have included experiments with mosquitoes. Papers along the above lines are published in "The Proceedings of the New Jersey Mosquito Extermination Association" (1944).

Specialists in subjects other than entomology, and experts in raising insects other than Culicidae are often faced with the problem of rearing mosquitoes; and as a result there are numerous requests for practical suggestions on rearing and for references to literature pertaining to mosquito culture and to the basic principles underlying mosquito development and behavior. In addition, there is a very real interest on the part of the general public in mosquitoes — their life-history, habits, and control. In recognition of the widespread need, it is proposed to make available in this article information along the following lines:

1. SMALL-SCALE REARING. Objectives. Equipment and procedure.
2. NOTES ON DEVELOPMENT AND BEHAVIOR. Water and food requirements. Effects of temperature, humidity, and light variations.
3. LARGE-SCALE CONTINUOUS REARING. Brief discussion of contributions from literature.
4. SELECTED BIBLIOGRAPHY. Articles referred to in text. Articles recommended for additional information.

SMALL-SCALE REARING

Maintenance of small colonies of mosquitoes does not require the exacting work nor complicated equipment necessary in large-scale projects where production schedules must be met. Small-scale rearing is valuable in research problems where only a few mosquitoes are needed from time to time. It has its place, also, in making available mosquitoes in all stages for study and demonstration in classrooms and other closely supervised assemblies, such as public educational exhibits maintained by mosquito abatement commissions, local improvement committees, and museums. These demonstrations can serve to educate children and adults by furnishing exhibitions of specimens and by

showing the actual effects of control measures recommended by county commissions or similar authorities. Small-scale oiling and dusting operations can be carried out in beakers or culture dishes; and small-scale tests or demonstrations of the effectiveness of sprays can be carried out in small cages.

It should be noted here that at times continuous rearing is not desirable or possible. Some species can be raised from larvae to adults with little difficulty, and females already fertilized when captured will generally deposit viable eggs. However, adults reared from these larvae or eggs may not mate in small cages, or they may not lay viable eggs. In these cases, only one generation of captive adults may be obtained for experimental purposes or for definite association of the immature and mature forms for identification. The following specific directions may be utilized for these purposes as well as for small-scale continuous rearing. It is possible, and entirely probable, that through numerous attempts and consequent modifications, additional species will be found adaptable to continuous rearing.

Practical suggestions for maintaining small colonies of mosquitoes must be prefaced by the statement that to my knowledge there are only four species of mosquitoes in the United States for which definite steps may be recommended for continuous rearing in small cages. These are *Anopheles quadrimaculatus* Say, a common human malaria mosquito; *Aedes aegypti* (Linn.), the yellow fever mosquito; *Culex pipiens* Linn., the northern house mosquito, and *Culex quinquefasciatus* Say (= *fatigans* Wiedemann of European workers), the southern house mosquito. We have reared a colony of *Anopheles quadrimaculatus* from October until August in a cage 10½ x 10½ x 15½ inches. We are securing viable eggs from individuals of this species emerging and

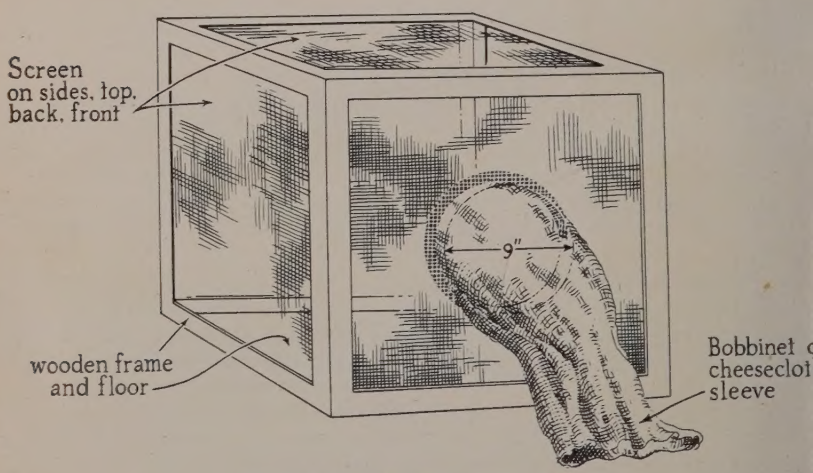

Figure 1. Mosquito Cage—2 x 2 x 2 feet.

mating in a cage only 10 inches square, and we have continued this lot since the middle of July of this year. We have reared *Aedes aegypti* continually for over two years in lantern globe cages (as described by Woke in 1937); the cages are approximately 6½ inches high and 3½ inches in diameter at the base. Huff (1937) also reported maintenance of *Culex pipiens* and *C. quinquefasciatus* in lantern globe cages.

EQUIPMENT FOR ADULTS

Cage.

With the above facts before us, it would seem practicable to use cages approximately 2 x 2 x 2 feet for all three genera, Anopheles, Aedes, and Culex. As we have noted, small cages can be used, but larger ones are more convenient, because they will provide room for the emergence pan for pupae, food for emerging adults, pan for deposition of eggs, and space for a host introduced to furnish a blood meal. The cage (Fig. I) should have a wooden floor and a sturdy wooden frame covered with wire screening or bobbinet. The screening should be copper or galvanized wire to prevent rusting, and the wooden frame should be painted to prevent warping. The screen should have at least 18 meshes to the inch to retain the smallest adult mosquitoes. The sleeve providing entry into the cage may be made of bobbinet or heavy cheesecloth. The cage may be varied in several ways; for example, a sliding panel or hinged door may be added, or the sleeve may be set in a hinged door. It is advisable to raise the cage an inch or two from the surface of the table so that water cannot collect under it. It is also advisable to cover the cage floor with paper or cloth which can be removed when soiled. Four towels, preferably Turkish, should be provided to cover each cage and these kept moist in order to provide necessary humidity.

Suction Tube.

Although adults may be caught in the cage and transferred by means of a vial about 1 inch in diameter and 4 or 5 inches long, a suction tube (Fig. II) is much more practicable. This consists of a rubber tube ¼ in. in diameter and about 18 in. long, slipped over one end of a glass tube ¼ in. in diameter, and about 6½ in. long. A plug in the end of the glass tube next to the rubber tubing prevents inhalation of the mosquito when suction is applied. The plug is made and inserted as follows:

A piece of index card, or preferably celluloid or old photographic film 1¼ x ¾ in. is rolled into a hollow cylinder ¾ in. long, with its diameter slightly less than that of the glass tubing. One end is placed in the center of a 1¼ in. square of cheesecloth (double thickness may be advisable) and both are pushed into the glass tube. This results in a thin cloth barrier stretched across the tube about ¾ in. from the end over which the rubber tubing is now slipped.

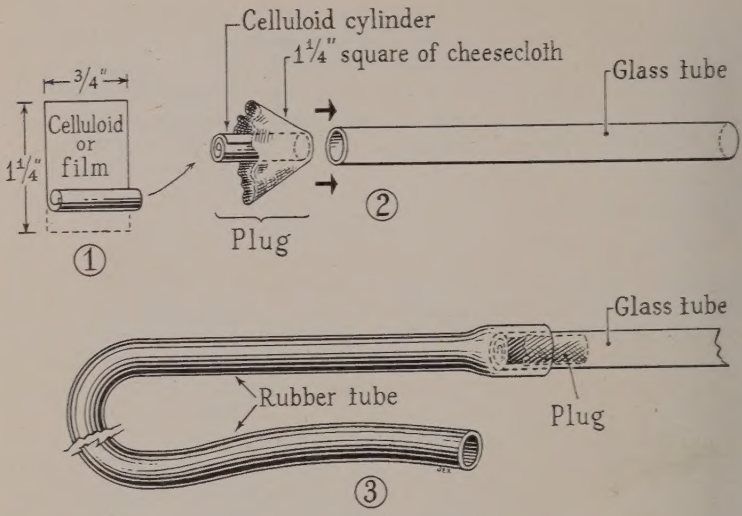

Figure II. Suction Tube

1. *Celluloid before rolling into shape.*
2. *Insertion of plug—semi-diagrammatic.*
3. *Completed suction tube.*

Feeding Apparatus.

Various devices are used to hold small animals quiet while female mosquitoes take a blood meal. We have used the apparatus illustrated in Fig. III; but there are others, and more can be improvised. A guinea pig or rabbit can be restrained in a tight-fitting hardware-cloth cylinder, closed at either end by wires, or by a fold of the material (Fig. III, 1). There should be no latitude for movement on the part of the animal, otherwise the mosquitoes will be rubbed off. A convenient chick-holder is made from a muslin square, or "blanket," a cardboard or wooden stand, a heavy rubber-band, and several straight pins (Fig. III, 2-4). The rubber-band is slipped under the flaps and stretched across the top of the stand and the muslin square is slipped under the band, so that the hole in the "blanket" and the opening in the stand coincide. The chick is then placed so that its clipped back rests over the openings; then the sides of the "blanket" are brought up and pinned securely with straight pins.

EQUIPMENT FOR LARVAE

White enamel pans are preferable for raising larvae, because the small immature forms show up better against a white background. Many workers use glass culture dishes, or even medium-sized glass or china bowls. In fact,

I raised larvae for three years in culture dishes about 8 inches in diameter by 3 inches deep because they were readily available. A white background, such as a sheet of paper or a towel, is helpful when transparent containers are used. Oblong trays, such as developing trays 16 x 9½ x 2 inches are excellent rearing pans. They are used in this laboratory for culturing 300-400 larvae of either Anopheles or Aedes. They hold at least 3 quarts of water. Round pans of similar capacity are likewise widely used. Briefly, containers for rearing larvae should have a capacity of at least 3 quarts, be 2 or 3 inches deep, and preferably, but not necessarily, white and opaque.

A convenient, but not essential, piece of equipment is a 50 ml. volumetric transfer pipette, shortened to 8 or 10 inches, and fitted with a rubber bulb. (Fig. IV). This is useful when one wishes to transfer several hundred larvae or a quantity of water to another container.

Salt-shakers are a convenient means of storing and dispensing powdered food to the larvae.

EQUIPMENT FOR PUPAE

Medicine droppers with the sharp end filed off to make a wide mouth are used for removing pupae. These droppers can be made by cutting 4 inch sections of ½ inch or ⅜ inch glass tubing and fitting each with a rubber bulb. Small white enamel pans or china bowls about 3 or 4 inches deep are excel-

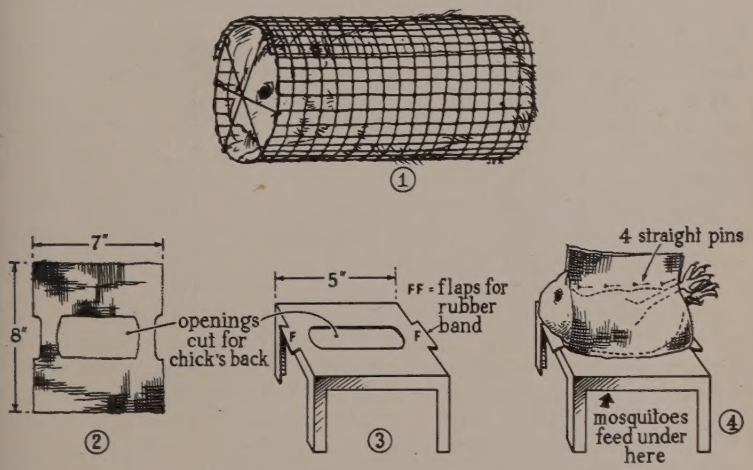

Figure III. Devices for restraining guinea pig and chick
1. *Guinea pig in hardware-cloth cylinder.*
2. *Muslin square for wrapping chick.*
3. *Small stand for holding chick.*
4. *Chick in place, ready to be set in cage.*

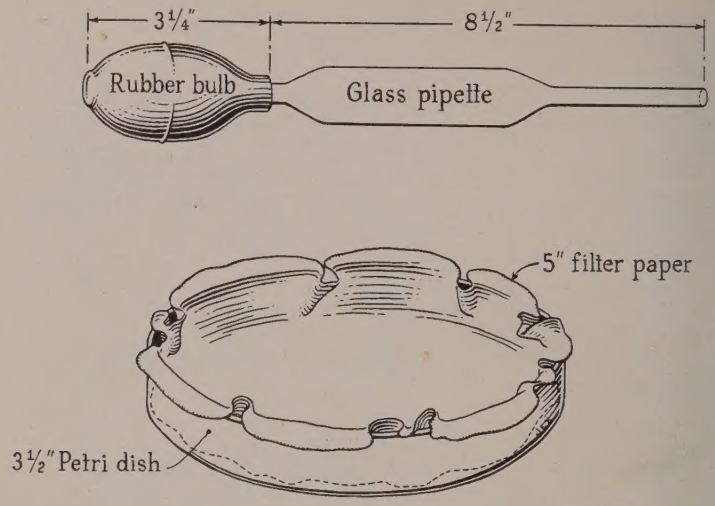

Figure IV.
1. *Pipette for transferring larvae.*
2. *"Pie crust" type container for oviposition.*

lent receptacles for water containing pupae awaiting emergence. The top and bottom halves of small petri dishes 3½ in. (9 cm.) in diameter and ½ in. (12 mm.) deep, may be used for this purpose also, but they hold only a small amount of water which can evaporate quickly.

EQUIPMENT FOR EGGS

Any of the containers used for pupae may be used for holding the water on which caged females may oviposit. If transparent glass dishes are used, a white background should be provided, such as a sheet of paper or a towel placed underneath the dishes, so that the eggs may be observed more easily. For mosquitoes that will not oviposit on open water, cellucotton pads are cut to fit into one-half of a 9 cm. petri dish, saturated with water, and covered with a circle No. 3 Whatman 9 cm. filter paper. Another useful egg-collector is a thin circle of paraffin about 9 cm. in diameter, with small holes punched in it to allow it to float just below the surface of the water in a small bowl.

Our most efficient egg-collector is one developed in our insectary and very aptly called a "pie-crust dish" (Fig. IV.). It consists of one-half of a 3½ inch (9 cm.) petri dish into which a 5 inch (12.5 cm.) filter paper has been fitted so that the fluted margins extend slightly over the edge like the lower pie-crust in a pan. The filter paper may be fitted easily without tearing if it is moistened before handling. The advantages of such a device are (1) that

the entire container remains moist as long as there is any water in the dish, and eggs laid on the sides and rim will not dry out as the water level recedes; (2) eggs are more easily washed from wet filter paper than from moist glass. In fact they frequently cannot be removed from the latter without injury.

FOOD SUPPLY AND PREPARATION

The following foods are suggested for the maintenance of a winter mosquito colony:

Dog biscuits (Purina dog chow is preferred)
Dehydrated skimmed milk
Whole oat grains (to be cut in half)
Dextrose
Ripe apples

Substitutions may be made to meet the wishes or demands of the worker. Adult mosquitoes will feed on fruit such as apples, grapes, moistened dried prunes, raisins, peaches, etc. in addition to sweetened water solutions, such as honey-water, and syrup-water. A 10% dextrose solution is prepared by pouring 50 grams (5 level tablespoonfuls) of dextrose into 450 cc. (approximately 1 pint) of distilled water. The dextrose dissolves more easily if it is added to the water, rather than the water poured over it. We have fed *Aedes aegypti* for several years on just granulated sugar dissolved in water.

Dog biscuits crushed to a coarse powder with a hammer or rolling-pin are ready for *A. aegypti* larvae. *Anopheles quadrimaculatus* require the same food as a very fine dust. This is prepared by grinding the coarse powder with a mortar and pestle, and then rubbing it through a double-thickness of fine cheesecloth. If necessary, this sieving is repeated until the powder is fine enough to float on the surface of the water in which the Anopheles are living.

WATER SUPPLY AND PREPARATION

Natural waters vary, and the choice of tap, pond, well, filtered, etc. will have to be left to individual workers. Distilled water, however, is almost always safe, and we use it exclusively. Bates "Medium S," which will be discussed later, consists of the following:

1 liter of distilled water
1 gram magnesium sulfate ($MgSO_4 \cdot 7H_2O$)
0.5 gram calcium sulfate ($CaSO_4 \cdot 2\,H_2O$)
0.5 gram sodium chloride (NaCl)

Rather than buy comparatively expensive chemicals, it is suggested that ordinary table salt and epsom salts be substituted for sodium chloride and magnesium sulfate, respectively.

EQUIPMENT FOR TEMPERATURE AND HUMIDITY

Maintenance of a colony of several hundred mosquitoes does not require constant temperature and humidity control devices. A temperature of 80° F.-85° F. is excellent for larvae, while 75° F. favors the longevity of adults. For general rearing work in one room, it is best to keep the temperature between

75° F. and 80° F. day and night. A maximum-miminum thermometer is useful for keeping a check on room temperatures in one's absence. A relative humidity of 80% is a good all-around humidity for this type of rearing, and it can be provided by means of 4 wet towels to each cage of adults. The towels are wet, wrung out to prevent excess dripping, and placed over 4 sides of the cage; one side is better left open. These towels should not be allowed to dry out. The moisture in a cage may be supplemented, if necessary, by a slight modification of Rozeboom's method (1936). An ordinary red clay flower pot is plugged at the bottom with cloth and filled with sand. This sand is kept wet, so that the pot will provide additional moisture and also a damp place for resting mosquitoes. The top is covered to prevent the females' ovipositing on the moist sand.

PROCEDURE FOR ANOPHELES QUADRIMACULATUS

We shall assume that you have *A. quadrimaculatus* eggs on damp filter paper. Prepare a larval rearing tray for each 300 expected larvae. Fill each tray with at least 3 quarts of water — preferably Bates' "Medium S." Add about ½ pint (250 cc.) of water from an old pan just prior to putting in the eggs; this furnishes food to the young larvae which should hatch within 48 hours. When the minute larvae are seen wriggling, dust a very small amount of powdered dog food on the surface of the water. Sprinkle small quantities of food into the trays every morning and evening unless the larvae are not consuming the food previously furnished. Excess food or food which has dropped to the bottom of the tray should be removed with a pipette, but care should be taken not to remove the larvae. Add water to replace that lost by evaporation. A fungus growth usually occurs on the sides and bottom of healthy trays of our *Anopheles* larvae. (This fungus was isolated by Dr. C. W. Emmons, Principal Mycologist, National Institute of Health, and has been identified by Dr. J. N. Couch, University of North Carolina, as a species of *Pythium*.) This is allowed to remain unless it ensnares the larvae; in this case, it may be removed in strips by means of forceps.

Developing larvae (especially Anopheline) should be protected from currents of air which disturb the water surface and often keep them in almost imperceptible but continuous motion. We discovered that the reason we could rear larvae on one shelf of a rack and not on the others was because of an air current from the air-conditioner. Such situations can be remedied by hanging up towels or arranging some other kind of barrier. If trays of larvae are placed in a glass enclosed cabinet, such as a bookcase, this situation is automatically taken care of.

At the end of about two weeks, the larvae will have attained full growth and pupae will begin to appear. Transfer these carefully by means of a wide-mouthed medicine dropper to a small container partly filled with water. Only about 30 pupae should be placed in a pan 4 inches in diameter and 2 inches deep, because crowding prevents complete emergence of adults. After all of the pupae have been picked, place the pans in a cage and fill each with water.

Small flat pieces of cork, about ½ inch square often assist newly-emerged adults in leaving the water.

A slice of ripe apple or a cellucotton pad saturated with dextrose solution may be placed in a small dish inside the cage. The 4 wet towels should be hung over the cage immediately, because the adults will begin to emerge within 24 hours. Keep the towels moist; and be sure that food is present at all times.

In about a week, the female mosquitoes will be ready for their first blood meal, which is necessary for oviposition. Feeding is encouraged by withholding fruit or dextrose for the 24 hours preceding the blood meal. Blood may be offered by placing your arm (the knuckles and fingers protected by a heavy glove) in the cage and allowing the mosquitoes to feed, or it may be furnished by a small animal such as a guinea pig, rabbit, or chick. The hair or down on the animal's back and sides is cut with clippers or small scissors, the animal partially immobilized by one of several methods (see instructions under *Equipment for Adults*), and placed inside the cage for 15 minutes. Removal of towels from the cage at this time will disturb the females and thus encourage feeding. Several hundred mosquitoes may bite, and it may be advantageous to quiet the guinea pig or rabbit by letting it nibble on a small piece of apple or carrot. We have seen guinea pigs accustomed to handling sit quietly without restraint in a cage with several thousand mosquitoes. After feeding, the mosquitoes should be allowed to settle down in the cage before you attempt to remove your arm or the animal; otherwise you will run the risk of some escaping when the sleeve is opened. Blood-meals should be furnished at least once a week.

After the females have had their first blood-meal, a small container filled with water should be kept in the cage continually for oviposition. As the water evaporates, it must be replenished in order to prevent eggs from becoming stranded on the sides of the container. Every third day they should be washed into trays for the next larval generation.

Procedure for Aedes aegypti

Each larval tray is filled with about 3 quarts of distilled water and prepared for eggs by adding food 12 to 24 hours in advance, or by adding about ½ pint (250 cc.) of water from a previously used pan just prior to putting in the eggs. This procedure is followed in order to stimulate hatching of the older eggs, as explained by Gjullin and co-workers (1941), and at the same time to furnish food for the young larvae. If eggs are received dried on filter papers, immerse the papers in the water and allow them to remain until at least several hundred larvae have hatched in each pan. This may require several minutes or several hours. All of the eggs may not hatch at the first submergence, and it is possible to remove the filter papers, dry, and store them for subsequent re-submergence and additional hatching. When the young wrigglers appear, add some coarsely powdered dog food and some oat grains cut in half. The larvae should be divided so that only about 300

are in each tray. Watch the pans carefully so that you do not overfeed. An excess of food will cause a film or pellicle to form on the surface of the water and kill the larvae. Normally, the water will discolor slightly with time, but this is not the cloudy, scummy appearance forecasting mortality. A small amount of dog food and about 20 oat grains cut in half are a daily quota for one pan of healthy larvae.

In about a week, pupae will begin to appear. These should be transferred to the cage in the same way as given for the *Anopheles quadrimaculatus*. The male pupae of *Aedes aegypti* are smaller than the females of the same lot, as described by Cantrell (1939). By saving only the females and a few males for mating, the maintaining of excess males may be eliminated. Unwanted pupae can be easily killed in hot water. Wet towels and food are provided as for the *Anopheles quadrimaculatus*. A blood meal is furnished as with the above species, but eggs are collected in a slightly different manner. We suggest that one-half of a small petri dish be fitted with a pad of cellucotton, saturated with water, and covered with a circle of No. 3 Whatman filter paper for oviposition. Fifty females will deposit on an average of 2,000 to 3,000 eggs a week on such a paper. When the paper is well-covered with eggs, remove the entire pad and allow it to dry at room temperature for about 3 or 4 days. In this way, the developing eggs are "conditioned" as explained by Shannon and Putnam (1934), and a greater per cent of hatch can be expected. These eggpapers once "conditioned" may be dried for several days or a year. However, the per cent of hatch decreases with time, and it is better if eggs are used within two months. A paraffin circle floated just below the surface of the water in a small bowl, as described under *Equipment,* is a less expensive, but not as efficient a method of egg collection.

Procedure for Culex pipiens and C. quinquefasciatus

Directions for hatching eggs and rearing larvae continuously are given by Huff (1937); and we suggest that the eggs be washed into the trays of water and the same method be followed as with the rearing of immature *Aedes aegypti*. Dehydrated skimmed milk is the food Huff recommends, and this should be given carefully with attention being paid to the amount the larvae are consuming. A combination of ground dog food and brewers' yeast is an excellent larval food, also. Pupae are removed to the rearing cage, which is furnished with wet towels, and fruit or dextrose for the emerging adults, and blood-meals provided — as with the preceding species. Eggs are laid on open water in dishes as are those of *Anopheles quadrimaculatus,* or they are deposited on saturated filter papers over cellucotton pads as are those of *Aedes aegypti*.

Precautions to be Observed

Everyone makes mistakes. For your convenience and from our own experience and observations, we have listed some pitfalls to be avoided.

1. Check your screening. Lay a ruler on the material and count the number of meshes yourself. Are there at least 18 meshes to one inch?
2. Verify the night and week-end temperatures of your rearing-room. Sudden changes in temperature play havoc with insect colonies.
3. See that pans for eggs and immatures are rinsed thoroughly. Unexplained larval mortality has been traced to a residue of soap powder.
4. Avoid undue disturbance of cages and pans containing mosquitoes. Emerging adults and ovipositing females should be absolutely quiet.
5. Do not pour water containing living larvae or pupae into the sink. Strain the water through cheesecloth or muslin and destroy the insects in boiling water. This will prevent development of mosquitoes in the sink-trap.
6. Avoid the use of insecticidal sprays in close proximitity to rearing room. Fly or roach sprays used five rooms away have adversely affected adult mosquitoes. Aeresols and DDT are even more dangerous.

NOTES ON DEVELOPMENT AND BEHAVIOR

The basic requirements of mosquitoes and the conditions affecting their development have led to much research on the water and foods favorable to mosquito rearing and on the responses of mosquitoes to varying degrees of temperature, humidity, and light.

Water and Food

A variety of waters — pond, rain, filtered, tap, and distilled — are among those recommended as best suited for larval culture. Natural waters vary, and the treatment of tap water in cities differs. In this laboratory, we find that more certain results follow the use of distilled water than with that drawn from the tap. Larvae will not develop and pupate consistently in tap water in the vicinity of Washington, D. C. Mosquito-workers from other parts of the country relate similar experiences. Granett and Haynes (1944) report the use of filtered water at New Brunswick, N. J.

Alkalinity or acidity of water (hydrogen-ion content or pH) has been the subject of much investigation. MacGregor (1929) concluded in part that "the influence of pH is of unquestionable importance and that its significance lies in the fact that, under natural conditions, it indicates the favorable or unfavorable association of chemical and biological factors in the breeding-places upon which the successful or unsuccessful development of the larvae depends." We used Squibb's Nitrazine papers to ascertain the approximate pH of cultures in our laboratory. New, old, thriving, average, and sickly lots were tested. *Anopheles quadrimaculatus, A. punctipennis, Aedes aegypti,* and *A. vexans* were tested according to directions, and the resulting color comparison showed no variations which could be correlated, except a tendency for the older cultures toward neutral. Water when placed in the pans is usually about pH 5.5.

Effects of various chemicals on larval breeding have been of interest to many workers. Bates (1941) found that the addition of certain salts to distilled water was favorable to the development of larvae of *Anopheles atroparvus, A. labranchiae, A. maculipennis,* and *A. superpictus.* We use his "Medium S" for much of our *Anopheles* rearing.

Larval nutritional studies have resulted in abundant literature. It is of interest to note that our experiences in raising Anopheline larvae seem to verify Hinman's assumption (1933) that a fungus may produce a growth-stimulating factor. Our thriving cultures of *Anopheles quadrimaculatus* exhibit a fungus growing along the sides and bottom of the pans, which if not thick enough to entangle larvae, is allowed to remain.

Adults have been fed a variety of fruits and sweetened waters. Research has shown that females and males will thrive on such diets, but that with a few exceptions, and for all practical purposes, blood meals are a pre-requisite for deposition of viable eggs.

Effects of Temperature, Humidity, and Light Variations

Temperature and humidity conditions have been reported on by many workers, including Shannon and Putnam (1934). Huffaker (1944) reared *Anopheles quadrimaculatus* in abundance for temperature studies, and discovered that the optimum temperature for larval development was around 31° C. (87° F.). Hurlburt (1943) also studied the rate of growth of this species in relation to temperature, and found that a constant temperature of 35° C. (95° F.) prevented rearing of this species while constant temperatures of 82° ± 1°, 74° ± 2°, and 64° ± 1° F. permitted continuance of the life-cycle. He concluded that there is an increased rate of growth with a rise in temperature, although he did not state that it was directly proportional. Both Huffaker and Hurlburt reared the larvae in accordance with the recommendations of Crowell (1940). Our general experience over a period of 8 years has been that adult mosquitoes will accommodate themselves to a rise in temperature more rapidly than to a decrease in humidity.

Jobling (1937) experimented on the development of *Aedes aegypti, Culex pipiens,* and *C. quinquefasciatus* in complete darkness. This is an informative paper, and should be read by those planning to maintain colonies of mosquitoes. Tate and Vincent (1932) found that *Culex pipiens* fed readily in the dark only after prolonged exposure to light. Marshall and Staley (1932) reported that *Anopheles* spp. *Culiseta* spp. (=*Theobaldia*) and *Aedes* spp. fed in daylight on human blood, while *Culex pipiens* was reluctant to engorge under the same conditions. Seaton and Lumsden (1941) have compared the effect of light and darkness on *Aedes aegypti's* biting. They state that light reduced by one-half the number of mosquitoes biting. We find that, for our purposes, *Anopheles quadrimaculatus, A. punctipennis, Aedes aegypti,* and *A. vexans* feed more readily in a subdued light, although when hungry enough, they feed equally well under a bright light or in almost total darkness.

LARGE-SCALE REARING

Large-scale rearing of mosquitoes has been carried on in laboratories all over the world. In the United States, material has been published on the rearing of some of our native species, *Anopheles quadrimaculatus* Say, *A. punctipennis* (Say), *Aedes aegypti* (Linn.), *Culex pipiens* Linn., *Culex quinquefasciatus* Say (=*fatigans* Wiedemann of European workers) and *Culiseta inornata* (=*Theobaldia inornata* Williston).

Anopheles spp.

Anopheles quadrimaculatus and *A. punctipennis* were maintained in large colonies by Boyd and co-workers who published accounts over a period of years (1926, 1930, 1932, and 1935). The 1932 and 1935 papers were arranged and published in a compilation by Galtsoff, Lutz, Welch, and Needham (1937). Equipment and procedures are carefully explained in all of these articles. Larvae were fed on hay or wheat infusions supplemented by yeast. Adults were kept in cages 8 x 13 x 10 feet.

Crowell (1940) rearing *A. quadrimaculatus,* found that he could substitute powdered dog biscuit as a larval food, and that one pound was sufficient for rearing 29,000 larvae. Larvae were reared in tap water in enamel pans 20 x 12 x 2 inches. Adults were fed fruit or 10% dextrose solution and were kept in cages with sides 40 inches square.

Burgess and Young (1944), in a well illustrated paper, summarize the method employed for *A. quadrimaculatus* rearing in the Columbia, S. C., laboratory.

Anopheles albimanus Wied. was maintained in a laboratory in Panama by Rozeboom (1936). He succeeded in keeping adults of this species in a cage 2 x 2 x 2 feet, at a temperature of 80° F. to 86° F. with relative humidity at about 80%. His method of supplementing moisture in the cage is noteworthy. He plugged one end of an unglazed drain tile, 12 inches long by 5 inches in diameter, with paraffin and cloth, then added sand, which he moistened daily. This provided the necessary extra moisture as well as a damp place for the resting adults.

Aedes aegypti (Linn.)

Large colonies of *Aedes aegypti* are maintained in laboratories throughout the world. This species was raised in abundance in a laboratory in Brazil, and excellent papers by Shannon and Putnam (1934) and Putnam and Shannon (1934) discuss methods and equipment thoroughly.

Granett and Powers (1937) describe their method of maintaining supplies of *A. aegypti* and *Culex* mosquitoes during the dormant season. They recommend a mixture of powdered skim milk, Harris brewers' yeast or Fleischman's yeast, and powdered dry bread.

Granett and Haynes (1944) report on the rearing of approximately 12,000 *A. aegypti* weekly for repellent tests. They use water filtered as explained in

their paper given at the Thirty-first Annual Meeting of the New Jersey Extermination Association.

At the same meetings, a method for providing at least 1200 female *A. aegypti* weekly, was offered by Trembley (1944). Larvae were reared in distilled water and fed oat grains cut in half, or a combination of oats and crushed dog biscuits.

Culex spp.

Culex pipiens and *Culex quinquefasciatus* are common rain-barrel or house mosquitoes. They are widespread, and much has been published on rearing them in captivity.

Huff (1937) in concluding a paper on rearing methods for *C. pipiens* and *C. quinquefasciatus* states: "When attention is directed to the essential requirements of these species it will be found that they may be grown with ease." He found a temperature of 80° F. preferable. He reared larvae in white enameled pans or refrigerator dishes and recommends dehydrated skimmed milk as food. The adults were kept in lantern globe cages and fed preferably raisins which had been cooked in a small amount of water. Further recommendations for the raising of these two species of *Culex* may be found in the paper by Granett and Powers (1937) already referred to, and other papers in the bibliography.

Culiseta inornata (=*Theobaldia inornata* WILLISTON).

Culiseta inornata was successfully established and maintained in a captive colony by Owen (1937 and 1942). A semi-balanced aquarium provided food and habitat for the larvae.

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THE MOSQUITO CONTROL INSPECTION TRIP

SPONSORED BY THE AMERICAN MOSQUITO CONTROL ASSOCIATION, OCTOBER 31st AND NOVEMBER 1st, 1944

EDITOR'S NOTE: It was a practice of the former Eastern Association of Mosquito Control Workers at least once each year to arrange a field inspection trip and conference to be held in the territory of some other regional Association. This was designed to provide for the exchange of ideas and experiences with groups of mosquito control workers beyond the boundaries of our own regional area. Among others, extremely profitable trips were made to the Canal Zone; to the Tennessee Valley region; and to different parts of the southern and southeastern coastal areas. Plans for trips to the central west, the southwest, and the far west were temporarily abandoned when travel became difficult.

When travel is no longer restricted, it is hoped that the American Mosquito Control Association may be instrumental in arranging or in encouraging such trips again, in the interest of promoting acquaintance and the exchange of ideas and experience more widely among the mosquito control workers of different regional areas.

Owing to travel limitations, an extended trip could not be arranged for 1944; so the trip described below was planned instead. Great credit is due to our Secretary, Thomas D. Mulhern, and to those who have worked with him, for planning and making arrangements for this, and former very profitable field inspection trips. Usually the planned itinerary has been carefully gone over in advance, to assure that every minute of the trip will be worth while.

In the report that follows, each local leader has been asked to tell about that part of the trip which lay in his own territory.

THE TRIP IN PHILADELPHIA, AND DELAWARE COUNTY, PENNSYLVANIA

By MAJOR RUSSELL W. GIES

The trip started with a luncheon in the private dining room of the Pennsylvania Railroad Thirtieth Street Station, Philadelphia, where the Association had as guests the Hon. Frederick G. Garman, Chairman of the City Council of Philadelphia, Dr. Rufus S. Reeves, Director of Public Health of Philadelphia, and Hon. Clarence L. Conner, Chairman of the Delaware County Board of Commissioners. Thirty-six persons were present.

After luncheon, the party left the station in cars provided. The first stop made was in south Philadelphia, just west of 20th and Pattison Avenue, about ¼ of a mile from the Philadelphia Naval Hospital. At this point, the work being done in filling in a swampy area by the new digging, loading and bull-dozing machine, known as the Traxcavator recently purchased by

the City of Philadelphia for Mosquito Control, was shown. This traxcavator is mounted on a D-4 Caterpillar tractor and costs complete approximately $5,000.00 delivered, including a bulldozer blade attachment to be used alternately with a ¾ yd. bucket. The Navy Department has a large number of men passing through Philadelphia for treatment at the Naval Hospital, who have been infected with malaria in the tropics; and special efforts are being made to prevent the breeding of malaria transmitting mosquitoes in the area around the Naval Hospital as well as the branch hospital at Swarthmore, Delaware County, Pa. The Navy is cooperating with the City of Philadelphia and Delaware County by supplying several medical corpsmen during the breeding season for supplementing the inspection work of locating mosquito breeding places in the vicinity of the hospital installations. This gives the City additional inspection personnel; and at the same time, the Navy secures good field training for its personnel on mosquito control. In the vicinity of the Naval Hospital and in fact throughout south and southwest Philadelphia, there is much low ground — some of it at or below sea level. This is being filled in as rapidly as possible. About one mile east of the Navy Hospital, the Pennsylvania Railroad has filled in over a million yards of fill in such low ground and the City of Philadelphia is also doing extensive filling in the same vicinity.

The next stop was outside of the west gate of the U. S. Navy Yard where a demonstration of a smoke producing machine, which produces smoke and acts as a vehicle for distributing various chemicals both as a protection against adult mosquitoes and as a larvicide, was given. The machine has been in use in the Navy Yard under the general supervision of Captain E. C. Carr, Senior Medical Officer, Medical Corps of the U. S. Navy, and was under the direction of Lt. Richard T. Holwerg, U.S.N.R., Ensign Blackhurst, Entomologist, U. S. Naval Hospital, and Ensign D. A. Bowling, U.S.N.R. The demonstration may furnish some ideas for use under various conditions in other parts of the country.

The party then proceeded past the rear of Fort Mifflin after crossing the Penrose Ferry Bridge over the Schuylkill River. From here on, most of the area is at or below sea level and the extensive system of canals which have been placed for drainage amounting to approximately 70 miles was shown. These canals require constant maintenance. Some of the area is also under pump control while other portions are handled through tide gates.

Passing the edge of Hog Island, which is now used for a shipping point, and the City Airport, recently placed under Army Control, a stop was made at the city line between Philadelphia and Delaware County. From here on a general view of the two-mile long hydraulic fill just being completed by the United States Army Engineers between the Delaware River and Tinicum Island Road was viewed. This area, which has just been filled south of Hog Island, was formerly a very bad mosquito breeding source; and the work done will help to cut down such breeding.

Just beyond this point, along the new Industrial Highway in Delaware

County, a new hydraulic fill was visited which is just being started. Two cranes were at work building the dike to confine a new fill which will cover nearly 500 additional acres of the Tinicum marshes. The area on the opposite side of the Industrial Highway is being placed under pumping control by the Delaware County Mosquito Extermination Commission, the contract for the pumping station having already been let and work is just being started. A visit was made to the site of the pumping plant, which is being placed on an old concrete foundation used as a site for a similar station during the last world war. The pump to be installed is a 12" Fairbanks Morse tube type pump with automatic flood controls. The pump will pump approximately 3,800 gallons per minute over the dike and into Darby Creek. These fresh water marshes which are at or below sea level are extremely heavy mosquito breeding places after rains. New ditching will be placed after the pumps are installed, the ditches averaging 8 ft. wide at the top and 4 ft. deep, with a V-shaped cross-section. The ditches will be blasted with dynamite as the quickest and cheapest way to provide this necessary drainage. The cost will approximate not over 30¢ per foot of ditch and approximately 4 miles will be dug. The Philadelphia and Delaware County area with 2½ million people is the second largest war production area in the United States; and mosquitoes produced in enormous numbers on the marshes have reduced war production in many of the large plants, including Westinghouse Electric and Manufacturing Company, Baldwin Locomotive Works, a plant which covers 550 acres, Sun Shipbuilding, General Steel Castings Co., etc. The large industries in the area are cooperating effectively with the work being carried on by the local authorities.

FLOODING OF BRIDGEPORT MARSH REDUCES MOSQUITO BREEDING

By THOMAS D. MULHERN

A stop was made on New Jersey Highway No. 44, which divides the marsh of several hundred acres area lying south of Raccoon Creek into two sections, one west of the road and the other lying to the east. This marsh was diked for many years, and shrinkage had reduced its surface elevation to a point below the level of mean tide in Raccoon Creek, which has a tide range of approximately five feet.

In 1942 the dikes were in good condition, but the tide gates were operating imperfectly and there was water standing almost continuously on the surface of the marsh and in the ditches. Vegetation was rank, and it was suspected that mosquito breeding was prolific. Accordingly a trap, which we refer to as the Bridgeport Trap, was set up on the southern edge of the marsh. The average catch was 615 mosquitoes per night, females only being counted. Of the total catch of 29,496, 14,527 were *C. pipiens,* 11,038 were *An. walkeri,* and 604 were *An. quadrimaculatus.* Anopheles larvae were taken in both sections of the marsh.

Before the summer of 1943 began, the dike west of the highway was breached by a storm, allowing the tides of Raccoon Creek to pour through the breach, thereby causing the water level on the marsh to oscillate with the tides. Most of the original vegetation was dead during 1943, and most of the marsh was covered with open water. No larvae could be found in the course of several inspections, although the marsh on the east side of the road, where the dikes had not been breached, was found breeding. The tidal action had apparently eliminated most if not all of the breeding on the western section of the marsh. The Bridgeport Trap for 1943 caught an average of only 99 female mosquitoes per night, while the total catch was 4574, of which 2833 were *C. pipiens,* 584 were *An. walkeri,* and 76 were *An. quadrimaculatus.*

During 1943 the dikes on the east side of the road were breached, flooding the eastern portion of the marsh, and allowing tidal action to take place. Both sections of the marsh are now covered continuously with water to a depth of several feet, most of the original vegetation is gone leaving open water areas, and the reduction in moquito breeding is reflected by the Bridgeport Trap records for 1944: an average catch of only 86, a total catch of only 1503, including 548 *C. pipiens,* 0 *An. walkeri,* and 2 *An. quadrimaculatus.*

Assembling at the Seaview Country Club at Absecon, New Jersey, for the night, after an excellent dinner those present held an informal meeting to discuss plans for making the American Mosquito Control Association an over-all service agency which would not encroach upon the functions of any regional association, and for making MOSQUITO NEWS universally representative in its field.

On Wednesday morning, the party left Absecon shortly after 8:00 o'clock.

THE TRIP IN ATLANTIC COUNTY, NEW JERSEY

By FRED A. REILEY, Superintendent

It has been a long time since the Atlantic County Mosquito Extermination Commission has had the honor of entertaining an inspection party. On November 1st, 1944 we led thirty-two members of The American Mosquito Control Association through Atlantic County.

Hurricane damage seemed to interest most, and our first stop was made in the northeast part of Atlantic City where considerable damage was still in evidence. Boardwalk gone, pier partly destroyed, houses completely destroyed and street ends washed away.

We then drove south on Atlantic Avenue and saw the damage at street ends in the residential districts of Atlantic City, Ventnor, Margate and Longport.

Next stop was on the east side of the Great Egg Harbor River to see the Mosquito Commission's No. 6 salt marsh ditch cleaning machine.

Unfortunately the tide was over the marshes and the delegates could not follow the machine. Orders had been given the driver to clean two hundred feet and run the machine to high ground where we would have a chance to

note the details and discuss the performance. Some must have misunderstood the plans and waded out to the machine in spite of the fact that they did not have boots.

The machine was finally brought to dry land where all could see it and the details were explained. This machine was built in 1929 and we were surprised at the interest displayed by all.

Mr. Mulhern asked for some description of salt marsh drainage; particularly of the area on the west side of the river. So we attempted to do so.

The area contains about eight million unit feet of drainage ditches installed about 1919 and last cleaned in 1929, 14 years ago.

The ditches at this time, average 50% or less efficient. Such would usually result in mosquito breeding. But when drainage was installed we decided that a complete drainage system should be done at once. Usually we dig main ditches and return the following year to note results and add supplementary ditching if necessary. Here every hole and depression, except deep salt holes, was connected to main ditches or natural outlets by hand dug spur ditches.

The result is that we are getting adequate drainage for mosquito breeding control in spite of lack of ditch maintenance.

We believe that ditches should be cleaned every three or four years. However, the above experience does show complete initial drainage will continue to function much longer than one partly drained. Dependence placed in the theory that breeding control can be accomplished by seepage into main ditches is likely to result in breeding.

We had nothing else planned to show and started for Cape May County to see more salt marsh problems.

INSPECTIONS IN CAPE MAY COUNTY, N. J.

By O. W. LAFFERTY, Superintendent and THOMAS D. MULHERN

The Fishing Creek Marsh in Cape May County, New Jersey, has an area of about 1200 acres, the elevation of which is approximately that of mean out tide. Drainage from this area is blocked by a storm bluff of shifting sand, such that neither ditches nor even the natural creek channel can be kept open. Special outlet structures also are exposed to direct wave action from Delaware Bay.

To meet this situation, two special outlet structures have been provided, each with a tide gate in a well at the inner end, set to prevent tide water from entering the marsh at high tide, and to allow drainage from the marsh at low tide.

One of these is a wood box culvert, 6 feet wide by two and one-half feet high and about 300 feet long. Its flow line elevation is approximately that of mean tide in Delaware Bay. This outlet was built by the county road department, to drain off water which threatened a road crossing the Fishing Creek Marsh, and its elevation is considerably above the desirable elevation for

Exposed Auxiliary Outlet, Fishing Creek Marsh, Cape May County, New Jersey. Shown at low tide, during inspection by American Mosquito Control Association. Member at left of group is standing on top of structure, which has been badly damaged by hurricane and plugged with sand.—Photo by T. D. Mulhern.

mosquito control purposes. The outer portion of the structure is above the surface of the beach and completely exposed to the action of the waves in Delaware Bay. It was severely damaged during the hurricane of September 14, and will require a great deal of repair work. Experience has shown that exposed structures on this beach are frequently damaged by storms, floating debris, or in the winter by ice which freezes to the structure at low tide and is lifted by the rising tide, carrying the structure with it.

The other outlet is an experimental unit, of corrugated galvanized iron pipe, 36 inches in diameter and 360 feet long, installed nine years ago by the Commission. It is in the form of an inverted siphon, and the outer end is completely submerged in the sand of the beach to a point at the level of mean low tide, where an upturned elbow discharges the outflowing water a few inches above the sand of the beach. Since the pipe is completely submerged in the sand of the beach between the low tide and the high tide limits, there is no interference with the movement of sand up and down the beach by the waves and a more stable shore line is maintained than with exposed structures on the beach which may act as jetties. This outlet has never been damaged by storms, nor has it ever become plugged with sand, for the water flows out at a sufficient velocity to sweep the pipe clear of any sand that may be deposited in it by waves.

Subterranean, "inverted siphon" outlet, Fishing Creek Marsh, Cape May County, New Jersey. Discharging at extreme low tide. Exposed to direct wave action from Delaware Bay, but not damaged by the recent hurricane. Type two outlet is used here because bay is very shallow and at low tide, sand bars (dark areas in background of photo) are exposed for a distance of more than 1,000 feet and length of pipe for a type one outlet would be excessive.

Photo by T. D. Mulhern.

At Shaw's Marsh, south of the Fishing Creek area a third sluice, smaller than the others and built of wood, was seen. This unit incorporated many construction features designed for strength which were worked out during the long experience of the Commission in building outlets through sandy beaches. This unit also withstood the battering of the seas during the hurricane.

The preferred type of tide gate for use with all of these outlets is the "pendulum" type, with the gate suspended on long arms and the hinge pin five feet or more above the top of the gate.

On Shaw's Marsh a demonstration was given of an amphibious jeep by Navy and U. S. Public Health Service personnel. The machine was driven down the road, over the sand dunes through brush, and out onto the salt marsh where it maneuvered with great facility, crossing wide and narrow ditches with ease. It was used during the past summer on the Fishing Creek Marsh, at the head of which is located a navy airport, for pulling out stumps

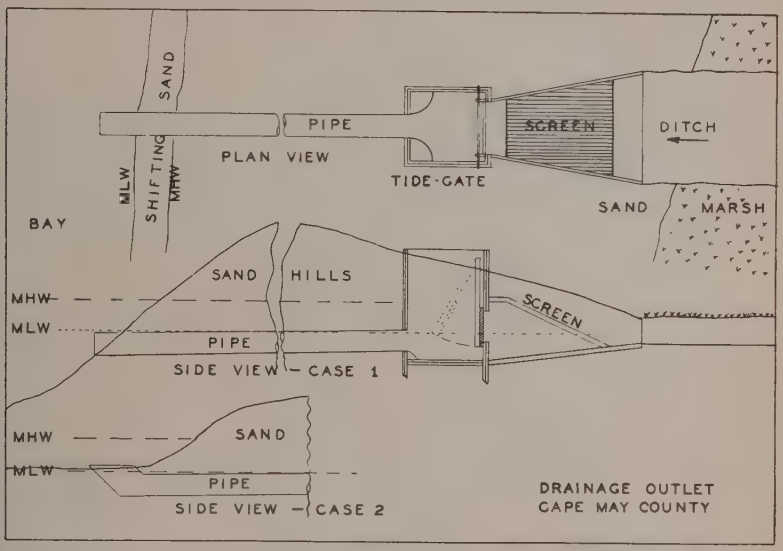


Diagram of drainage outlet developed in Cape May County, New Jersey, for use where shifting beach sand prevents the satisfactory operation of open ditches .Case 2 illustrates the "Inverted Siphon" type which has given such satisfactory service at Fishing Creek Marsh, where the outlet must discharge into a very shallow part of Dalaware Bay. From Article by O. W. Lafferty, Proceedings 31st Annual Meeting of the New Jersey Mosquito Extermination Association, March, 1944.

and wreckage from ditches, for spraying, and for transporting men. Such machines should be very useful to civilian mosquito control agencies after the war if they can be secured.

The new canal across Cape May County near its southern end was visited. It connects the Inland Waterway with Delaware Bay, and eliminates a dangerous passage for small vessels about the infamous "Rips" at the confluence of the waters of Delaware Bay with those of the Atlantic Ocean. It is a sea level canal, without locks, and has a minimum channel width of 100 feet and a 12 foot controlling depth. It is three miles long and was constructed by hydraulic dredge in approximately 90 days. Unfortunately the spoil was placed in areas where it interfered with drainage. Examples of this were seen at the Delaware Bay end of the canal. Some work has been done to correct the condition, but the improvement is incomplete.

In the course of the development of the City of Cape May, an open creek was inclosed in a five-foot diameter pipe, extending for a distance of more than a half mile under the city. The pipe is at an elevation too high to drain a 400 acre enclosed marsh, formerly a typical salt marsh, which now receives principally fresh water and is somewhat polluted. At the upper or west end

of this marsh are located Army, Navy and Coast Guard Units, and here a mechanical mosquito trap has taken catches of over 100 *An. quadrimaculatus* female mosquitoes in a single night. To aid the Commission in providing protection for the nearby residents and various units of the armed forces, the County Board of Chosen Freeholders is constructing a tide gate and pumping station at the inner end of the pipe to elevate the water from the marsh so that it may drain by gravity through the pipe into the tide water. The concrete sump and supporting structure has been completed, and was inspected. The two tide gates and a 12" vertical propeller pump for low-head service will be placed in position and will begin operation in the spring of 1945.

At the conclusion of the observations described, the inspection party dispersed: some leaving by train from the city of Cape May, others by automobile. All pronounced the trip a very profitable experience.

IN MEMORIAM

A TRIBUTE TO JOHN P. PETERSON

By JESSE B. LESLIE, *Executive Secretary*
The Bergen County Mosquito Extermination Commission

Back in 1915 I first met John P. Peterson. At that time I had just come into Bergen County from Camden County to take charge of the mosquito work then being started in Bergen. One of my first jobs was to recruit a field force. I interviewed a number of young men at the Court House who had applied for jobs. Among them was a rawly faced youngster with a ready smile who impressed me with enthusiasm. He had become interested in mosquito control as one of the original survey party in Hasbrouck in 1914 and he thoroughly believed that the work was practical and could accomplish great results. His faith and enthusiasm appealed to me so I hired him.

In the fall of that year the working force unfortunately had to be cut down. Or the suggestion I used the old "Mother Hubbard" One Finger On the applicant. I could keep but one inspector. I chose John Peterson. Others had more formal education, perhaps could write more flowery reports, but none of them could equal John's practical results. I would back "Pete" every time.

And so the association began: an association that continued uninterrupted for nearly thirty years except for 1917-1918, when we were separated while he was in the Army, at the United States Quartermaster Depot at Jeffersonville, Indiana, on "Pete's" insistence, and where I found on a visit some years later, he became the Superintendent in full charge of the relief work of the Commission.

If there ever was a leader in their or a more conscientious one, I've never met him. Hours meant nothing, and Saturday afternoons and Sundays were like any other day if there was mosquito work that needed to be done. During the early days of the Commission when the air-minded were being drawn and enlisted in the work that generation against it had to be overcome. Peterson was just as missionary as inspector. His personality put the work across time and time again. Pete was known from one end of the County to the other. Farmers and their people took to him, they were friendly toward the work. Mayors, Councilmen, Engineers, Health Officers, Freeholders—all knew John Peterson,—knew him as a mosquito man; knew him as a conscientious, honest, hard-working public official; knew him and trusted him.

And because every taxpayer that knew my boy knew him at the work, our tax enthusiasm for it, his hard sense and good judgement and no doubt the Bergen County Commission as a board in the run, and was many proud of the position taken by this Commission under his leadership.

He was destined to the end. The day before he died, when many a less determined man would have given up, he was at his desk. It was a privilege to have been associated with such a man, and I feel that the work that he gave his life to means lasting progress because of his untiring efforts.

NEWS AND NOTES

New Members. Applications for membership were approved at a special meeting of the Executive Committee on October 31, 1944, as follows: Carl E. Anderson, New Jersey, Associate; Vernon Conant, New Jersey, Active; Leroy Childs, Oregon, Active; F. R. DuChanois, Texas, Associate; W. G. Jahnes, New Jersey, Active; Philip H. Harden, Louisiana, Associate; Albert A. Weathersbee, Virginia, Active. T.D.M.

A New Recruit.—*Mosquito News* is happy to announce the arrival of a new mosquito fighter, "Johnny-Cake" Mulhern. His arrival, via the stork, took place on June 3, 1944.

R. L. Vannote.

T/Sgt. C. R. Strickland, 29th Malaria Control Unit, has sent four kodachrome snapshots entitled: "A Native Inspection Team" (passed by U. S. Army Censor, one reproduced below) and writes: "Somewhere in Senegal W. Africa—October 24, '44. Given some two weeks training, these natives proved highly efficient when working in pairs. The work seemed to fascinate them and they learned quickly to distinguish Anophelines from Culicines and to differentiate both from other aquatic life." Signed, "Strickland." T. D. Mulhern.

A Native Inspection Team—Strickland
Somewhere in Senegal West Africa

JAMES T. HART of the Morris County (New Jersey) Mosquito Extermination Commission writes that he is now in New Guinea and would like to hear from some of us. His address is Capt. James T. Hart, Jr., 0-519296, 105th Malaria Control Unit, A.P.O. 565, c/o Postmaster, San Francisco, Calif. T. D. M.

THE FLORIDA ANTI-MOSQUITO ASSOCIATION. Fred H. Stutz, Director of the Dade County (Florida) Anti-Mosquito district, writes to say that the Florida Anti-Mosquito Association which has been inactive for the past few years will resume active operation possibly some time this spring by holding a meeting whicih has been tentatively scheduled to be held in Tampa. Best wishes to the Florida Association for a successful meeting. T. D. M.

THE NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION will hold its 1945 Annual Meeting, the thirty-second of the series, at Atlantic City in March. Dates have not yet been fixed, but will probably be in the latter half of the month. T. D. M.

We have the following notes from Harold F. Gray, Engineer and Executive Officer, Alameda County Mosquito Abatement District:

DR. STANLEY B. FREEBORN, Senior Surgeon, U. S. Public Health Service, who has been malariologist for Malaria Control in War Areas at Atlanta, Ga., has been released and has returned to Berkeley as Professor of Entomology and Assistant Dean of the College of Agriculture at the University of California. H. F. Gray.

DR. MORRIS A. STEWART, Associate Professor of Parasitology at the University of California, has recently returned from a four months assignment in Bolivia and Brazil. On the way he visited the remarkable Instituto Biologico at Sao Paulo and the Instituto Oswaldo Cruz at Rio de Janeiro. H. F. Gray.

MAJOR THOMAS H. G. AITKEN, Sanitary Corps, U. S. Army, is reported to have been formerly in Italy and later in Egypt. We understand that he has done considerable work on malaria and mosquito control in these areas. Tommy was formerly a graduate student under Professor W. B. Herms, while working for his Ph.D. degree, and did very valuable work in straightening out the *Anopheles maculipennis* complex in the Western United States. H. F. Gray.

HARVEY G. LUDWIG, Assistant Sanitary Engineer, U. S. Public Health Service, who was formerly in charge of the *Aedes* Control Unit in New Orleans, is said to have been transferred to Europe under U. N. R. R. A. H. F. Gray.

(This report is confirmed by Mrs. Harvey Ludwig.—T. D. M.)

WILLIAM T. INGRAM, Sanitary Engineer, U. S. Public Health Service, who was formerly Sanitary Engineer for the San Joaquin Local Health District in California and did some excellent mosquito control work in that County, is reported also to have been transferred to Europe under U. N. R. R. A. H. F. Gray.

CAPTAIN HOMER W. JORGENSEN, Sanitary Corps, U. S. Army, who was formerly an Assistant Sanitary Engineer in the California State Department of Health, is reported to be in charge of an Army malaria control unit in the South Pacific. H. F. Gray.

A. H. GEIB, who has been supervising mosquito control work for the Bureau of Sanitary Engineering of the California State Department of Health, has recently resigned and is reported to be engaged in some Army educational work. Mr. Geib was formerly Secretary-Treasurer of the California Mosquito Control Association. H. F. Gray.

Harold F. Gray, Engineer and Executive Officer, Alameda County Mosquito Abatement District, was in Chicago on Nov. 2nd-6th, and while there took advantage of the opportunity to visit J. Lyell Clarke and observe the mosquito control operations and equipment of the Desplaines Valley Mosquito Abatement District. H. F. Gray.

A Special Training Course for Mosquito Control Workers.—The new School of Public Health at the University of California gave an intensive training course on the control of mosquitoes and mosquito-transmitted diseases on December 4th-16th. Of this Mr. Gray writes: "This is the first course of this type to be given on the Pacific Coast, and it may be the first course of this type to be given anywhere in the United States (excluding, of course, formal University courses for University credit). Ross Institute of Tropical Hygiene has given such short courses in England in the past, and short courses in malariology have been given, I think, by the India Branch of this Institute in India."

We have before us a circular describing this course, entitled "'Announcement for SPECIAL TRAINING COURSE ON CONTROL OF MOSQUITOES AND MOSQUITO-BORNE DISEASES," December 4 to December 16, 1944. School of Public Health and Division of Entomology and Parasitology, College of Agriculture, University of California, Berkeley, California.

A few excerpts from this announcement should be of interest:

"For the past twenty years or more the control of mosquitoes has been recognized as a service function of government, for the protection of individuals, industry and agriculture against disability, death and economic loss. The implications of the preesnt war with its return of possibly infected military personnel from tropical areas now accentuates the need for this service . . . , and has resulted in requests for specific training . . . .

"Heretofore specific training has not been available . . . , except in regular university courses.

Admission

"*Requirements*: Applicants must be actual or immediately prospective employees of state or local health departments, or of an official agency engaged in mosquito abatement, and must be recommended for this training by the head of the department or official agency . . . .

"Enrollment will be restricted to 30 students."

Courses Offered

I. Administration and Management. Mr. Herms, Mr. Gray.
II. Entomology and Parasitology. Mr. Herms and Assistants.
III. Mosquito Transmitted Diseases. William W. Reich.
IV. Techniques of Control. Mr. Gray and Assistants.

Fees and Expenses

The tuition fee of $50 covers the required laboratory and incidental fees.

Hotel and meals (15 days at $7.50) estimated at about $115.00. Two hotels near the campus have arranged to reserve rooms for students in this course. Reservations with deposit to be made 3 weeks in advance.

Books and incidental materials are estimated to cost $10.00.

Total expenses, including transportation estimated at about $175.00.

"It is assumed that departments or districts will defray the expenses of officers or employees sent to the course, as well as paying their regular salaries."

This course is an important and a logical development. Recent years have seen a progressive extension of the short course idea, through short courses for farmers, short courses for firemen, short courses for policemen, short courses for town officers, short courses for municipal treasurers and the like, with growing emphasis on such special training courses

designed to keep service workers in government up to the minute with reference to new developments in their respective special fields.

It is to be hoped that qualified institutions may follow California's lead, and offer similar short courses for mosquito control workers in other regional areas. R. D. G.

NEWS FROM VENEZUELA. ANOTHER SPECIAL TRAINING COURSE FOR MOSQUITO CONTROL WORKERS. We are happy to have the following from Dr. Arturo Luis Berti, Ing. Jefe de Seccion, Division de Malariologia, Ministerio de Sanidad y Asistencia Social, Salubridad Publica, Maracay-Aragua, United States of Venezuela.

"The most important event in connection with mosquito control right now is the course of Malaria Control for doctors and engineers offered by the Division of Malariology and now under way in its new building and laboratories at Maracay, Aragua.

"This course has been divided into two sections: one for medical doctors and the other one for engineers engaged or interested in malaria control. It is a four-month course for each section. The first two months are devoted to study of the following subjects:

Doctors:

I. Hematology.
II. Entomology.
III. Protozoology of Malaria.
IV. Pathology.
V. Symptomatology.
VI. Therapeutics.
VII. Meteorology.
VIII. Epidemiology.
IX. Antimalaria Engineering.
X. Antimalaria Administration.
XI. Antimalaria Legislation.

Engineers:

I. Protozoology, Symptomatology and Therapeutics of Malaria.
II. Entomology.
III. Sanitation.
IV. Meteorology and Hydrology.
V. Antimalaria Equipment.
VI. Epidemiology of Malaria.
VII. Drainage and Irrigation.
VIII. Mosquito Control.
IX. Antimalaria Administration.
X. Antimalaria Legislation.

"The last two months will be spent by the students working as assistants of the doctors and engineers of the Division of Malariology in its routine work.

"Twenty-nine Doctors and Engineers from different countries are attending the course, as follows:

1 from U. S.
15 from Venezuela.
4 from Colombia.
3 from Ecuador.
2 from Peru.
4 from Bolivia.

"The students are working under fellowships provided by the Venezuelan Government, the Institute of Inter-American Affairs, the Rockefeller Foundation and the Guayaquil City Government, Ecuador." Dr. A. L. Berti.

A FATAL CASE OF FLEA BORNE BUBONIC PLAGUE IN HONOLULU. The Hawaii Health Messenger for August, 1944, Volume IV, No. 2, reports: "One fatal case of bubonic plague with secondary pneumonia was reported during the month from the Kalopa district. The patient, ill for about six days before reporting to the doctor, died the following morning. This man had been working in an area where plague infected rats have been found during the past year." R. D. G.

TYPHUS FEVER AND PLAGUE IN HAWAII. The Hawaii Health Messenger for August, 1944, Volume IV, No. 2, reports a generally favorable health record and mortality rate for the preceding fiscal year, but adds: "On the other side of the ledger we are forced to admit that we had far too many typhus cases in the past year. One hundred eighty cases with one death was reported, and plague still continues to challenge the best efforts of the Health Department. Seven cases were reported from the Big Island, all of which proved fatal."

NEW JERSEY ACTS TO PREVENT MALARIA OUTBREAKS. In 1935, the most recent malaria epidemic in New Jersey occurred in a county which had no anti-mosquito work. That year there were 155 cases in the state.

The annual number has been usually under 20 and these are mostly infected persons coming into the state from malarious regions.

Since the United States entered the war an increased proportion of the mosquito control effort has been placed on the control of *Anopheles quadrimaculatus,* but it has not been practicable to completely eradicate the species, though only small numbers can be found over most of the protected region.

Anticipating the rise in numbers of malaria cases which has occurred this year, principally in service men back from the war zones, and their probably wide geographic distribution, a cooperative program was adopted by the various county mosquito extermination commissions, local health departments, State Department of Health and the State Agricultural Experiment Station to prevent epidemics by quickly following up with malaria and mosquito control measures the cases which appear in civilian areas.

Malaria has been reportable since 1911, the physicians being required to promptly notify the health authorities when a case comes to their attention.

Under the cooperative control plan, the local health department notifies the State Department of Health and the county mosquito extermination commission immediately of the location of the case. Representatives of the two agencies visit the patient, preferably together, as soon as practicable; the former to get a complete case history and to present instructions in protective measures the patient may take to help prevent epidemics by preventing the infection of mosquitoes; and the latter to inspect the premises for malarial mosquitoes, to subsequently survey the one mile zone about the premises for breeding places, and to take corrective measures as may be needed. This direct notification insures inspection within a minimum length of time. Meanwhile, the State Department of Health notifies the State Experiment Station, which in turn sends a confirming notice to the county mosquito commission. Upon completion of the field procedure, a report on the mosquito conditions is prepared by the mosquito commission and distributed to the other agencies.

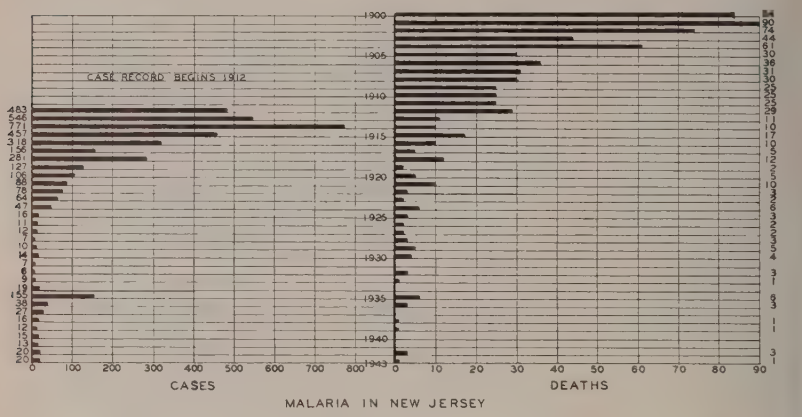
Where this procedure cannot be followed, as where there is no county mosquito commission, or no local board of health, the state agencies complete the routine, taking whatever action is indicated by the circumstances surrounding the individual case.

The State Department of Health has on hand a supply of dimethyl phthalate mosquito repellent which it may furnish in small quantities to the malaria patient when it is deemed advisable as a supplement to the other protective measures recommended.

Through civilian sources, 34 cases were reported in the first 10 months of 1944. Most of these on investigation proved to be service men on leave or discharged who had acquired malaria abroad.

On the military reservations there have been many more cases and these are being given all the protection practicable by the military personnel, while the U. S. Public Health Service is also doing some work adjacent to a few camps where there is a definite population of human malaria carriers and malarial mosquitoes.

It is gratifying that there has been no epidemic any place in the state; yet there is



Malaria in New Jersey has declined steadily during the period in which the mosquito control work has been expanded. However, as recently as 1935 an outbreak occurred in a portion of the state which was without protection from mosquitoes. This epidemic was brought under control through the cooperation of health and mosquito control agencies, through the execution of a mosquito control program.

always the possibility that though all practicable precautions be taken, in any place where any *Anopheles quadrimaculatus* remain, a human malaria carrier not under treatment may escape notice until an infected masquito population is established. The mosquito control work must therefore be advanced as rapidly as possible.

See graph showing malaria cases and deaths in New Jersey from 1900 to 1943.

Thomas D. Mulhern.

SCREEN WIRE DEMANDS INCREASED. On July 21 the W. P. B. reported that 1944-45 total demands for wire screen cloth are estimated to be 24 per cent greater than for this fiscal year, and that present labor forces in the screen industry must be increased if both civilian and military demands are to be met. The Army and Navy requirements are forecast at a 25 per cent increase and civilian needs will go up from 325 to 400 million square feet.

Based on the above W. P. B. estimates, it appears likely that civilian supplies will be short indeed, for even during this year it was very difficult to get screen cloth in some regions, and the estimated rise in military requirements, which must be met, doubtless means that less will be available for civilian use. It appears that wire screen production requires much labor and cannot now be easily increased because of the labor shortage. Wire screen cloth which may now be manufactured is limited by W. P. B. Order L303 to 12 mesh per inch painted wire and 16 mesh painted or galvanized wire. Only 8 widths can be manufactured, ranging from 24 inch to 48 inch. This standardization, with the elimination of many sizes, may aid the industry to turn out a greater total volume. The 12 mesh is, of course, too large to keep out mosquitoes, though house flies and larger insects cannot come through it. Some 14 mesh screen has been sold for mosquito protection, but the smaller mosquitoes can come through it. The increased size of opening over 16 mesh is hardly noticeable by casual observation, though readily determinable by measurement. Some of the complaints we have heard to the effect that "all my doors and windows are screened but mosquitoes still get in the house" are traceable to 14 mesh screen.

Adequate screen protection has been taken for granted for so long that it is difficult to

imagine the profound effect upon our way of life that would result should we be deprived of it. But we can at least readily imagine flies, mosquitoes and other insects spreading disease and interfering seriously with human activity at home and at work, in both urban and suburban regions.

Malaria was sharply reduced in many parts of the country about the time when the use of screening was becoming general, and certainly the present day low level of fly borne disease is due in large part to intelligent use of screening.

All of which indicates the advisability of encouraging to the utmost the preservation of existing screens by careful maintenance. Thomas D. Mulhern.

TO REGULATE REMOVAL OF TOP SOIL. In an effort to end the practice of unregulated removal of top soil, three municipalities in Union County, N. J., have passed ordinances prohibiting such work without securing a permit from the municipal engineer. The ordinances provide that prior to the issuance of a permit (license), plans for the complete drainage of resulting depressions must be approved by the licensing authority. This is a step in the right direction and it is hoped that similar ordinances may be enacted concerning the removal of trees which, in many cases, result in holes that hold water and breed mosquitoes.

R. L. Vannote.

Mr. Richard F. Sherry, Chief Inspector, Union County (New Jersey) Mosquito Extermination Commission, has provided a copy of the ordinance referred to above, which reads as follows:

"TOWNSHIP OF SPRINGFIELD,
COUNTY OF UNION

"An Ordinance to Regulate the Removal of Soil

"BE IT ORDAINED by the Township Committee of Springfield in the County of Union that the following shall constitute 'AN ORDINANCE TO REGULATE THE REMOVAL OF SOIL':

"Section 1. Any person or owner desiring to make any excavation or to remove soil from premises in the Township of Springfield in the County of Union shall first file with the Clerk of the Township an application for a permit to make such excavation or to remove soil and a map of the premises showing the proposed contour lines and proposed grades resulting from such intended removal in relation to the existing topography of the premises, and the said proposed contour lines and proposed grades shall be subject to approval by the Engineer of the Township of Springfield. No permit for soil removal shall be issued until such map has been filed and until the contour lines and grades have been approved by the Engineer of the Township.

"Section 2. In the removal of soil, the owner, applicant or person in charge shall so conduct operations that there shall be no sharp declivities, pits or depressions and so that the area shall be properly leveled off, cleared of debris, and graded to conform with the contour lines and grades as approved by the Engineer of the Township of Springfield.

"Section 3. The applicant, owner, or person in charge in the removal of soil shall not take away the top layer of arable soil for a depth of four inches, but such top layer of arable soil to a depth of four inches shall be set aside for retention on the premises, and shall be re-spread over the premises when the rest of the soil has been removed, pursuant to levels and contour lines approved by the Engineer of the Township.

"Section 4. In the removal of soil or dirt the owner, applicant, or person in charge shall make use only of such streets for transportation as are designated for that purpose by the Engineer of the Township.

"Section 5. Before any permit for soil removal shall be issued, the applicant or owner shall file with the Township a bond with surety and amount subject to approval of the Township Committee, the amount to be determined after report by the Township Engineer as to necessities and requirements in the undertaking, which bond shall be conditioned that the work of soil removal shall comply with the ordinances and regulations on the subject, and shall be done in proper manner, in accordance with the grades and contour lines approved by the Engineer of the Township, and that the top layer of soil, to a depth of four inches, shall be set aside and retained to be thereafter re-spread over the area when the rest of removal has been completed, and that repairs at the expense of the owner or applicant shall be made to any street or streets used in transportation if the Township shall consider repairs are necessary because of such use of the streets, and that the work shall be properly done without detriment to adjoining properties or detriment to the Township and without leaving any sharp declivities, pits or depressions, and will be leveled off properly and cleared of debris, and that the owner or applicant will pay the costs of inspection and supervision incurred by the Engineer of the Township in examination and inspection during the progress of the soil removal.

"Section 6. No excavation shall be made and no soil shall be removed unless a permit therefor shall have been first obtained as provided herein, and no excavation shall be made and no soil shall be removed except in conformity with the provisions of this ordinance.

"Section 7. Any person, firm or corporation violating any of the provisions of this

ordinance shall be subject to a fine not exceeding Two Hundred Dollars ($200.00), or to imprisonment for a term not exceeding thirty (30) days or to both in the discretion of the court.

"Section 8. This ordinance shall take effect immediately after publication in the manner provided by law.

"I, Robert D. Treat, do hereby certify that the foregoing Ordinance was introduced for first reading at a regular meeting of the Township Committee of the Township of Springfield in the County of Union and State of New Jersey, held on Wednesday evening, July 19, 1944, and that the said Ordinance shall be submitted for consideration and final passage at a regular meeting of the said Township Committee to be held on Wednesday evening, August 9, 1944, in the Springfield Municipal Building at 8 p.m., at which time and place any person or persons interested therein, will be given an opportunity to be heard concerning such Ordinance.

"R. D. TREAT,
39-40 "Township Clerk."

This ordinance is indeed a move in the right direction, since it seeks to correct a prolific source of mosquito breeding; yet, as originally proposed, it seems capable of being construed in ways that might interfere unduly with the legitimate improvement of private property. R. D. G.

EXCERPT FROM AN INSPECTOR'S REPORT. "In the lower part of Simonelli's roams a crazed bull who nearly gored several farmhands to death and who has a particular dislike to mosquito exterminators. It seems that this bull—Ferdinand as Peterson and I affectionately call him—has broken his nose-ring and they are unable to control him so that he has free reign of the lower portion of Simonelli's, which, however, is fenced in.

"I, not wishing to shirk my duty as a mosquito inspector, ventured into the field where the ferocious beast grazes and proceeded nonchalantly to spray. A cry of warning from Pete told me my mistake and I turned to face a snorting, hoofing, bellowing monster who, after giving me the once over, proceeded in my direction at no mean speed preparing to play a little football with me. Without waiting for signals from the quarterback, I streaked for the distant fence which I took in one hurdle, leaving my playful friend for some Spanish Toreador to take up where I left off.

"In case you doubt this episode, evidence may be obtained by a future trip to Simonelli's, where you, too, will be welcomed by Ferdinand." From R. L. Vannote.

EDITORIAL SECTION

THE AMERICAN MOSQUITO CONTROL ASSOCIATION AND MOSQUITO NEWS

During the past three years, under pressure of the war emergency, mosquito abatement work has advanced prodigiously; both in volume of effort, and in the refinement of old, and the development of new techniques. As never before, public interest has been focused through direct or indirect personal experience upon the importance of mosquitoes as a health hazard, not only in war areas abroad, but at home as well.

Much of this activity and public interest will continue into the post war period. Then, however, with the withdrawal of the present coordinating war agencies, the work will doubtless revert largely to the status of dependence upon local interest, local initiative, local administration, and local resources.

The organization of active regional associations will help, as it has helped in the past; but until recently, no over-all, nation-wide, much less continent-wide, or hemispheric agency had been developed to provide a medium through which those concerned with mosquito control and related work in all of its forms might work together to advance their common interests.

The AMERICAN MOSQUITO CONTROL ASSOCIATION can become such an over-all agency if its members wish. As such, it can become a medium for the mutual integration of activities in its field; a medium through which all can work together for their common good; through which moral support for beginning, or for weaker mosquito control agencies can be given by those which are already well established and secure. Within some regional areas, these things can be done by members of the regional group; but in other regional areas this may not be practicable, with the result that there is large field for inter-regional cooperation that will add strength even to the strongest local, and even regional agencies.

At present, the rapidly expanding literature of mosquito control and related work is widely scattered in a multitude of periodicals, to which the average mosquito control worker does not have ready access. Even those who are most favorably situated find it difficult to cover the field thoroughly enough to keep fully up to date.

For the majority of workers in this field, it would be a great convenience if a really considerable, and appropriately selected portion of the literature of mosquito control and related work could be brought together in one periodical. Mosquito News can do this if our members wish to have it so.

MOSQUITO NEWS can serve to keep individual mosquito abatement agencies as well as regional groups profitably in touch with each other. It can provide a medium for the exchange of information about new ideas and new developments. It can interpret new mosquito abatement techniques and resulting new requirements for manufacturers and suppliers; and, in turn, it can bring to the attention of practical mosquito control men, new mechanized equipment and the like, which could be used in, or adapted for this work.

But just how can the ASSOCIATION and MOSQUITO NEWS accomplish all of this?

First and most important comes increase of membership. If each member would exert himself to induce all of his associates and acquaintances who should be interested, to apply for membership, MOSQUITO NEWS could very quickly be increased in size, and even changed from a quarterly periodical to become a bi-monthly or perhaps even a monthly journal.

Nothing worth while is impossible if we will only work for it hard enough, and all together.

A NEW FORMAT FOR MOSQUITO NEWS

This december number of MOSQUITO NEWS is experimental, and is offered for your comment and suggestion. The dimensions are the same as the three preceding numbers, so the four numbers of Volume 4 can be bound together if desired. Tentative plans for the first (March) number of the next (1945) volume contemplate a slightly larger page, 6 inches by 9 inches, which would make it standard bulletin size. This would permit a two column page, which is easier to read. Please let us have any ideas that may occur to you for further improvement of MOSQUITO NEWS. Also, please keep on sending items for the *Notes and News section,* and any other matter that might be of interest to your fellow mosquito control workers in your own, and other regional areas. R.D.G.

WHY NOT WRITE TO MEMBERS WHO ARE OVERSEAS?

Below are the names and addresses of several members of the American Mosquito Control Association who are overseas. Those of us who are not yet privileged to share their work in war areas can prepare ourselves better for that work if it should come to us later, and we can in some measure contribute vicariously to it even now by writing to these men overseas. In doing so, we can keep them in touch with new developments at home before knowledge of these developments can be put into general circulation through publication; and from them we can get much general information about their

problems, such as may be passed by censor, which would prepare us better to meet overseas problems if we should eventually be called ourselves. R.D.G.

SOME MEMBERS OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION WHO ARE OVERSEAS, AND HOW THEY MAY BE REACHED BY LETTER.

Sgt. Carl E. Anderson, 42011052
94th Malaria Control Unit
A.P.O. 503, % Postmaster
San Francisco, California

P. B. Brockway, Pharm. M 2/c USN
#600, % Fleet Post Office
San Francisco, California

Lt. Elias J. Candel, Sn.C.
106 Malaria Control Unit
A.P.O. 565, % Postmaster
San Francisco, California

Lt. Walter A. Connell, Sn.C.O.-475965
22nd Malaria Survey Unit
A.P.O. 709, % Postmaster
San Francisco, California

Capt. J. T. Hart, Jr., O-419296
105 Malaria Control Unit
A.P.O. 565, % Postmaster
San Francisco, California

Sgt. Earle D. Potter, 34641934
2nd Malaria Control Unit
A.P.O. 705, % Postmaster
San Francisco, California

Capt. John W. Scott
Inf. Co. E. E.
A.P.O. 15186, % Postmaster
New York, N. Y.

S/Sgt. Claude R. Strickland
29th Malaria Composite Unit
A.P.O. 622, % Postmaster
Miami, Florida

Pfc. Jerry C. Cotrone, 31145887
Surgeon's Office Hdq.
A.P.O. 958, % Postmaster
San Francisco, California
(Stationed in Hawaii)

From T.D.M.

REVIEWS AND ABSTRACTS

MOSQUITO INTERMEDIARY HOSTS OF DISEASE IN AUSTRALIA AND NEW GUINEA by Frank H. Taylor, F.R.E.S., F.Z.S. Service Publication (School of Public Health and Tropical Medicine), Number 4, Commonwealth of Australia Department of Health. June 15, 1943 (154 pp. 75 figs.).

The purpose of this publication as stated by the author is to give a concise description of the essential morphology of the adults, pupae and larvae of the various species of mosquitoes (in the area under consideration) concerned with the transmission of disease together with practical details of control. The author frankly pleads guilty to the crime of piracy. Better than half of the material in the publication is quoted directly. No doubt, as the author states, this procedure saved him "many weary hours of writing." The publication starts out with the essential morphology of Anophelines and the characters used in identification and classification; there follows less than five pages of quoted descriptive material on bionomics and relation to disease based on generalized Indian and European observations; very little that would be helpful to workers in the area under consideration.

Next the publication presents systematic descriptions of species within the Australian and New Guinea area belonging to the various genera, *Anopheles* (5 species), *Taeniorhynchus* (one species), *Aedes* (5 species), *Culex* (3 species). For each species a brief statement is made regarding its relation to diseases, for example. *Anopheles bancrofti*: "No information is available in regard to the ability of this mosquito to transmit malaria in Australia." *A. amictus*: "Evidence *is* lacking as to the part this species plays in relation to malaria in Australia and New Guinea. It is an efficient intermediary host of *Wuchereria bancrofti*." *A. punctulatus* and its variety *moluccensis* are recorded as efficient intermediary hosts of malaria. Considerable space is devoted to *Aedes aegypti* and *Aedes albopictus* and are both recorded as efficient vectors of dengue. *Culex fatigans* is recorded as occurring throughout Australia and widely distributed in New Guinea and a most efficient intermediary host of *Wuchereria bancrofti*.

The remaining third of the publication is devoted to such items as collecting larvae in the field, determination of intermediary hosts of malaria, dissection technique, distribution of Anopheles and malaria in Australia, range of flight, protection against bites of moquitoes, screening of houses, barracks, etc., mosquito traps, fumigation (about four pages devoted to sulphur dioxide). The last twenty pages are devoted to measures directed against the larvae of mosquitoes. Concise directions are included for mounting and care of mosquitoes. There is a goodly list of references.

W. B. Herms.

A PRACTICAL ENTOMOLOGICAL COURSE FOR STUDENTS OF MALARIOLOGY (Third Edition). Revised and Illustrated by I. M. Puri, M.Sc. (Punjab), Ph.D. (Contab.), F.R.E.S. Entomologist to the Malaria Institute of India. Health Bulletin No. 18, Malaria Bureau No. 9. Published by Government of India Press, Calcutta, 1942, VIII, 189 pp., 168 figs. (Price Re. 1-12 or 2s. 6d.)

As the author points out, this bulletin was first prepared in 1933 by Captain P. J. Barraud especially for use by the malaria classes of the Malaria Institute of India. The second edition was published in 1938. The present edition is arranged in fifteen lectures with practical work outlined for each exercise. The first lecture is concerned with (1) General description of the structure of mosquitoes; (2) The Classification of the Animal Kingdom; (3) How to distinguish male and female mosquitoes. The "practical work" outlines methods and procedures for the examination and observation of laboratory material. Lectures 2 and 3 deal with detailed descriptions of the morphology of the mosquito with appropriate practical work.

Lectures 4, 5, and 6 are concerned with mosquito larvae, their morphology, methods of collecting, et cetera. The practical work comprises field collecting, observations on larval feeding habits, rearing *Anopheles* from eggs, and general characters of pupae.

Lectures 7, 8, 9, 10 and 11 are concerned with the identification and bionomics of adult mosquitoes, particularly anophelines. The practical work consists of collection of adult mosquitoes, their identification and feeding habits, testing blood meals by precipitin tests, etc.

Lectures 12, 13 and 14 give an excellent account of the internal anatomy of adult mosquitoes, particularly *Anopheles,* with special reference to the gut, the salivary glands, and reproductive organs. The several accompanying practical work outlines pertaining to the methods of dissecting out and examination of the salivary glands, mid-gut and reproductive organs are quite comprehensive and most valuable.

The fifteenth and final lecture with practical work gives a good account of the enemies and parasites of mosquitoes. Appendix 1 provides useful information on the classification of the Animal Kingdom, Coelomata, Arthropoda, Insecta, Diptera, and Anophelini together with a list of species and varieties of *Anopheles* found in India and Ceylon. Appendix 2 gives alternative names used by various authors for different parts of the thoracic segments, wing veins and cells. Appendix 3 gives a useful list of references important to malariologists, and Appendix 4 lists equipment supplied to students.

All entomologists engaged in malariological work should be familiar with this very important publication. W. B. Herms.

GLOBAL EPIDEMIOLOGY—A GEOGRAPHY OF DISEASE AND SANITATION by Brigadier General James Stevens, Lt. Colonel Tom F. Whayne, Lt. Colonel Gaylord West Anderson, and Major Harold Maclachlan Horsch. This is a J. B. Lippincott selected professional book and sells for $7.50. Volume one, just published, contains 2 parts; the first on India and the Far East, the second on the Pacific Area.

The authors describe the volume as "an excursion into the unexplored field of geomedicine, bringing together in one place certain data on medical, health, and sanitary conditions of various geographic areas of the world." It's really a "must" reference for entomologists, sanitary engineers, and physicians in Public Health who are responsible for keeping our fighting men fit. No doubt the information contained in this work will be important also to the peaceful, post-war world as well. Surely it represents the first collection of this kind of data between the covers of one book.

An outline of chapter 1 will suffice to illustrate the scope and magnitude of this very readable treatise. Each of the geographical divisions is so outlined.

1. Burma
    - Geography and Climate
    - Public Health
        - Health Services
        - Water Supplies
        - Sewage Disposal
        - Insects and Animals
        - Food and Dairy Products
        - Miscellaneous Problems of Sanitation
    - Medical Facilities
        - Hospitals
        - Medical Personnel
        - Medical Institutions
    - Diseases
        - Diseases spread chiefly through intestinal tract
        - Diseases spread chiefly through respiratory tract
        - Disease spread chiefly by contact
        - Diseases spread by arthropods
        - Nutritional diseases
        - Miscellaneous conditions
    - Summary

The sections of greatest interest to medical entomologists and mosquito control workers are those which describe the insects and diseases spread by them. For example, the known vectors of malaria, dengue, yellow fever, and filariasis are given for each of the 34 geographical divisions of India, the Far East, and the Pacific Area. Adequate maps and generous bibliographies also aid in making this book of 504 pages a basic reference in the fields of tropical and preventive medicine.

In subsequent volumes similar data, say the authors, will be made available about Africa, Europe, the Near East and the Western Hemisphere. H. H. Stage.

PROCEEDINGS OF THE THIRTY-FIRST ANNUAL MEETING OF THE NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION (1944). 198 pp. $1.25.

Several things lift the thirty-first annual proceedings out of the ordinary. One of these is the interesting story of "Thirty-Two Years of Progress" on mosquito extermination prepared by Robert B. Gray, of the Associated Press in Newark, N. J. This article covers the period during which Dr. Thomas J. Headlee was in active leadership of the work.

Worthy of a place in any mosquito fighter's library is the lead article in the proceedings by F. C. Bishopp and H. H. Stage, of the Bureau of Entomology and Plant Quarantine. This article reviews the contributions to the knowledge of mosquitoes made during 1943.

Another interesting paper deals with mosquito-borne diseases already brought into this country from war areas. Written by Dr. Thurlow C. Nelson, professor of zoology at Rutgers University, the paper discusses dengue or "break-bone fever," yellow fever, malaria, and the filariases. The article is interestingly illustrated.

An interesting historical article is the account by Albert W. Lafferty, of 40 years of mosquito control work in Cape May County, New Jersey. The article gives a graphic picture of the trials and tribulations experienced by county mosquito extermination commissions. An accompanying article by O. W. Lafferty, describes how a difficult problem — that of providing a successful outlet for drainage channels through sand beaches — was solved.

Always valuable is the annual summary by Thomas D. Mulhern of mosquito control work in New Jersey. The 1943 summary contains the usual tables reporting the New Jersey survey of adult female mosquitoes.

Mosquito technicians will be interested in articles by members of the Rutgers University staff dealing with "Improved Methods of Rearing *Aedes aegypti* for Use in Repellent Studies," "Methods of Testing the Value of Mosquito Repellents," and a report of the effect of mosquito larvacides on mosquitoes and fish. A number of representatives of mosquito control organizations in various states tell in the proceedings how they managed to conduct their work at a high level of efficiency in spite of wartime shortages of men, materials and machinery.

Throughout the proceedings are found discussions of the danger of malaria outbreaks in this country and the work that is being done to control the vectors of this dreaded disease. A dozen and a half illustrations add to the attractiveness of the book, although wartime shortages made it impossible to print these illustrations on enameled stock.

Sam Reck.

MOSQUITO CONTROL. By Lieutenant Colonel William B. Herms, Professor of Parasitology, University of California, and Harold F. Gray, Consulting Civil Engineer and Lecturer in Public Health, University of California. Published by the Commonwealth Fund, New York, 1944, XIV+419 pp., 86 figs., 9 tables, 11 plates, and 6 special appendices. (Price $3.50.)

Entomologists and Mosquito Control Workers all know and have used the first edition of this indispensable book. To them, the book needs no introduction; but all will welcome this new and enlarged second edition, which was made necessary by the new developments in mosquito control techniques which have come so rapidly in recent years, particularly in response to military needs, both at home and in war areas abroad. In its new form,

MOSQUITO CONTROL is well designed to serve the needs of military forces and rehabilitation agencies in all parts of the world, as well as those of civilian mosquito control workers at home.

The treatment of the subject is admirably comprehensive and well organized. For example, Chapter I is an introductory orientation chapter which first directs attention to the fact that "mosquito abatement is a development mainly of the last forty years," contrasts early attitudes with present attitudes toward such work; then traces ORIGINS OF MOSQUITO CONTROL with examples; discusses MOSQUITO SPECIES briefly in the light of their diversity of life histories and habits, to refute the too common misconception that "mosquito control is simply a matter of squirting a little oil here and there on water"; and finally outlines the GENERAL PRINCIPLES OF MOSQUITO CONTROL, and of MOSQUITO ABATEMENT AND DISEASE PREVENTION.

Chapter II deals with the IMPORTANCE OF MOSQUITOES and of mosquito borne disease, with special reference to the COST OF MALARIA and SUGGESTIONS FOR ESTIMATING ECONOMIC LOSS.

Chapter III is concerned with LAWS AND AGENCIES FOR MOSQUITO ABATEMENT. Summaries of mosquito control legislation by various states are given and critically analyzed, with comments on defects and possible improvements, particularly with reference to the relative desirability of operation through special improvement districts, or under the administrative or at least the fiscal control of already existing minor civil divisions, such as counties, municipalities and the like.

In this chapter there appears one very natural error. Of the New York law it is said: "Mosquito extermination commissions may be appointed in any county in New York State (not including New York City) . . . " That this is not the case is carefully provided for in the wording of the New York law under which the existing mosquito extermination commissions are organized, beginning: "In a county of the state of New York, adjacent to a county which contains not more than three towns and which is adjacent to a city of the first class, having a population of over three millions, . . . "; these are limiting "weasel words," the significance of which is easily overlooked.

Chapter IV, PRELIMINARIES TO ABATEMENT PROCEDURES, is especially noteworthy for those contemplating new mosquito abatement projects, since it outlines the development of a mosquito abatement district from the PRELIMINARY SURVEY AND REPORT, to sample budgets and specimen report forms appropriate for use by the going project. Especially interesting is the section relating to the duties and compensation of the EXECUTIVE OFFICER, followed by section relating to other personnel including DIVISION FOREMEN, LABORERS, and CLERICAL ASSISTANTS.

Chapter V stresses ways and means for EDUCATION OF THE PUBLIC and the importance of maintaining an understanding public interest in the work.

Though space will not permit their analysis in detail, the remaining chapters are equally well considered, well organized, and pertinent, as their titles indicate:

Chapter VI, FINDING MOSQUITO BREEDING PLACES.

Chapter VII, ABATEMENT METHODS: GENERAL PRINCIPLES. Here careful consideration is given to the problem of co-ordinating sound mosquito abatement procedure with wildlife conservation.

Chapter VIII, DRAINAGE AND RECLAMATION OF FRESH-WATER MARSHES.

Chapter IX, DRAINAGE AND RECLAMATION OF SALT-WATER MARSHES.

Chapter X, FILLING, PUMPING, AND FLUSHING.

Chapter XI, OILS AND LARVACIDES. This chapter contains one of the first, if not the first, published reference to the effectiveness of DDT as a mosquito larvacide; a striking example of the up-to-dateness of the book.

Chapter XII, METHODS OF APPLICATION OF OILS AND LARVICIDES.

Chapter XIII, MOSQUITO CONTROL BY USE OF FISH.

Chapter XIV, SUPPLEMENTARY PROTECTIVE MEASURES.

Chapter XV, SPECIAL FEATURES OF MOSQUITO CONTROL IN URBAN AREAS.

Chapter XVI, SPECIAL FEATURES OF MOSQUITO CONTROL IN RURAL AREAS.
Chapter XVII, SPECIES SANITATION AND NATURALISTIC CONTROL.

The several appendices are a notable feature of the book. Appendix A, Part II, THE PRINCIPAL ANOPHELINES OF THE WORLD, THEIR TYPICAL BREEDING PLACES, AND THE REGIONS WHERE THEY OCCUR, has been enlarged, the latest nomenclature adopted, and rearranged in alphabetical order; and, as Part II, a chart has been added giving THE MOST IMPORTANT *ANOPHELES* MOSQUITOES TRANSMITTING MALARIA IN THE PRINCIPAL REGIONS OF THE WORLD ARRANGED ACCORDING TO THEIR MORE TYPICAL BREEDING PLACES, TOGETHER WITH THE USUALLY APPLICABLE CONTROL MEASURES.

Appendix B gives MOSQUITO VECTORS OF YELLOW FEVER, DENGUE, FILARIASIS, AND EPIDEMIC (VIRUS) ENCEPHALITIS.

Appendix C gives A CLASSIFICATION OF MOSQUITO ABATEMENT METHODS.

Appendix D is IDENTIFICATION OF MOSQUITOES—USE OF KEYS.

Appendix E gives, in addition to the Bibliography at the end of each chapter, a SELECTED LIST OF BOOKS AND ARTICLES ON MOSQUITO SPECIES AND BIOLOGY.

The book is well indexed and, in addition to a very full Table of Contents, is provided with separate indexes to Tables, to Plates, and to Figures.

This book, also, is an admirable example of bookmaking. The excellent halftone illustrations and the large and openly set type (12 point type, 2 point leaded) make the book exceptionally easy to use without fatigue; and many features of the editing could be studied with profit by those with manuscript to prepare. Particularly worthy of study are the use of center heads and side heads, and especially the arrangement of tabular matter. Tables usually have few columns and no vertical rulings. Where vertical lines must be used, the table, specimen forms, and the like are drawn and reproduced as line cuts. Notable, also, is the clear, large, and generously spaced lettering of graphs, diagrams and maps.

It is an extremely useful book that one can own and use with pleasure, satisfaction, and profit.

R. D. Glasgow.

THE MOSQUITOES OF NORTH AMERICA. Their structure and habits, study and identification, how they carry diseases, methods of control. By Robert Matheson, Professor of Entomology, New York State College of Agriculture at Cornell University. Second Edition, Revised and Amplified. Comstock Publishing Company, Ithaca, New York, 1944, VIII+272 pp., 33 plates. (Price $4.00.)

A copy of this valuable "Handbook for Students of Entomology and General Biology, Health Officers and Sanitary Engineers, and Others Interested in Public Health" came to the editor's desk just as copy for the December number of MOSQUITO NEWS was being made ready for mailing to the printer. The importance and timeliness of this completely revised and amplified new edition seem to demand its immediate review; for the many who have used the first edition will wish to know that this long expected new edition is now available.

In this revised edition, PART I, MOSQUITOES: A COMPREHENSIVE SURVEY, as in the first edition, comprises

Chapter I. CHARACTERISTICS OF MOSQUITOES.
Chapter II. THE BIOLOGY OF MOSQUITOES.
Chapter III. MOSQUITOES IN RELATION TO HUMAN WELFARE.
Chapter IV. THE PROBLEM OF MOSQUITO REDUCTION; and
Chapter V. HOW TO STUDY, COLLECT, REAR, AND PRESERVE MOSQUITOES.

This part of the revised edition, however, though somewhat condensed, contains much new material, both new data and new illustrations, bringing this part of the book up to date with reference to recent work on yellow fever, encephalitis, mosquito control work in the Tennessee Valley, the introduction and eradication of *Anopheles gambiae* in Brazil, and the like.

PART II, A SYSTEMATIC ACCOUNT OF NORTH AMERICAN MOSQUITOES, comprises the mosquito species of North America north of Mexico, for which new keys to the genera and species have been prepared, and which are described, as far as practicable, with notes on their life histories, habits, and distribution. A new section on the *Chaoborinae* (*Corethrinae*) has been added. This new edition contains a much expanded bibliography; and to the plates, a new series showing the male genitalia of the species of *Chaoborinae* has been added. The book should be even more useful and popular than its predecessor.

R. D. G.

Trenching Machines Mark New Era in Land Drainage in Britain. By E. A. G. Johnson, Land Drainage Division, British Ministry of Agriculture. Construction Methods, McGraw Hill, New York 26 (1944), 7 (July); 58-61, 142, 144, 146, 148 and 150.

I don't know how other people first look through a new magazine; but I read all the illustrations first, cover to cover. So in the July issue of "Construction Methods" I thought I was "reading" an article on mosquito control in England.

The story proved to be "Trenching Machines Mark New Era of Land Drainage in Britain," by E. A. G. Johnson, Land Drainage Division, British Ministry of Agriculture.

Mr. Johnson's problems brought back memories of the past thirty years, during which time much effort has been spent in developing machines that could dig ditches for drainage purposes in the many acres of salt marsh in New Jersey. Of course this was for mosquito breeding control, and we are still striving for that perfect machine that will dig ten thousand or more feet of 10 x 24-inch ditch per day. We have dug ten thousand feet in one day, but could not maintain that average. We still have hopes.

I note that one of the machines described by Mr. Johnson appears to be cutting sod in the form of a ribbon, but apparently this is a trench in which tiles are laid and the main trench was dug by hand. We in New Jersey have gone further than that. We dig a ditch ten inches wide and as deep as thirty inches with a special plow that cuts the entire ditch in one cut and lays the sod on the bank in one or two pieces or ribbons, and at a rate of thirty-five feet per minute.

We are now getting away from the ribbon idea and are concentrating on the endless chain and bucket, mounted on specially built caterpillar chasis. This forms a unit that both cuts new ditches and cleans old ones. We feel that we have the right idea, and with its perfecting will be very well prepared for mosquito breeding control on our salt marshes.

Mr. Johnson's report on the mole plow is something to make us mosquito fighters sit up and take notice. We have done a lot of talking about this method of drainage, but have done very little about it. Mr. Sammis of the Suffolk County, Long Island, Mosquito Commission has been using the mole plow for over ten years and has found it very satisfactory. Most of the drains have been working for the entire time and still seem to be in good condition. Some men have tried it in New Jersey, but did not find it very satisfactory. This might be due to the very small tidal range. I feel that experiments with this type of drainage should be continued.

Our problem of upland drainage differs greatly from that of Mr. Johnson. Mr. Johnson's ditches seem to have one or both banks clear of trees and bushes, while our drains may run through forest or swamp. This lack of obstructions makes such work comparatively simple and there are many machines that will do this work.

In Britain the object was to get the job done and apparently labor was available and price not the object. This is illustrated by Mr. Johnson's description of the Kerry-Pratt all steel ditch cutter. This machine cuts sides and bottom of the ditch, but the spoil has to be removed by hand labor. This must be very expensive; too expensive for mosquito control work in New Jersey.

The Buckeye Ditcher to my mind is the best ditch digger on the market were it not for the fact that it digs ditches with parallel perpendicular banks. This type is all right for tile, but not for open ditch. We use very little tile in New Jersey.

The Henderson ditcher is an interesting development of the endless chain and bucket. The spoil is lifted from the ditch by spade-like blades mounted on a wheel. Of course the spoil only comes to the surface and it pushed from the bank by two mold boards.

As Mr. Johnson points out, the average ditch in England is about three feet deep, eighteen inches wide at the bottom and five feet wide at the top. Some ditch. The work on these ditches was done by the Priestman dragline excavator with a side arm attachment. By the use of this side arm the bucket can be pulled on the line of ditch. The bucket is built to conform to the shape of the desired ditch. Also the tractor can be run on one bank far enough from the ditch that there is no danger of cave ins.

This idea of ditch digging and cleaning will probably appeal to at least one of New Jersey's mosquito men. He has the problem of cleaning ditches on his salt marsh that are too wide to straddle with the present cleaning machine and cannot be reached from a distance from the ditch bank.

While the idea may appeal, the strain caused by the side arm will require a very heavy tractor rig. Much too heavy to travel on the salt marshes. Also of no use in swamps and forests.

We have had running through out mind a machine for cutting or cleaning upland ditches. Crazy perhaps, but runs somewhat as follows:

A caterpillar of say eighteen-inch wide tread. This to be run on line of or in the ditch. The main caterpillar to be balanced by smaller caterpillars or wheels to run both sides of the ditch and so controlled that the main caterpillar is always kept in balance. The drive to be on the main caterpillar. These of course would be connected to a chassis that would carry the engine, gears, etc., and either a power shovel or endless chain buckets. Hydraulic power could be employed for most of the movements.

This is but a dream; but as I look back most of our equipment started as a dream, and lots of it remained dreams that never came true.

However, I still think that some of our mosquito fighters with lots of upland drainage should put more thought to developing a good machine for a very necessary work.

There, New Jersey mosquito fighters, is one right in your laps, and don't try passing it back to the writer. He is having his own particular headache with equipment for the salt marsh.

Fred A. Reiley.

Pathology of Experimental Poisoning in Cats, Rabbits, and Rats with 2, 2 Bis-Parachlorphenyl 1, 1, 1 Trichlorethane. By R. D. Lillie, Senior Surgeon, and M. I. Smith, Chief Pathologist, United States Public Health Service. Public Health Reports, 59 (July 28, 1944): 979-984.

The Pharmacologic Action of 2, 2 Bis (P-Chloro-Phenyl) 1, 1, 1 Trichlorethane and Its Estimation in the Tissues and Body Fluids. By M. I. Smith, Chief Pharmacologist, and E. F. Stohlman, Associate Pharmacologist, United States Public Health Service. Public Health Reports, 59 (July 28, 1944): 984-993.

Histopathological Changes Following Administration of DDT to Several Species of Animals. By Arthur A. Nelson, John H. Draize, Geoffrey Woodward, O. Garth Fitzhugh, R. Blackwell Smith, Jr., and Herbert O. Calvery, Division of Pharmacology, Food and Drug Administration.

These three papers are of interest to mosquito control workers in common with workers in other fields of pest control, because their significance seems to have been misinterpreted, with the result that they have been cited as a source of alarm concerning DDT as a possible health hazard, which might delay its full use as an insecticide.

DDT undoubtedly has remarkable insecticide properties. Its value as a delousing agent is now well known. Herms and Gray (Mosquito Control, 1944 Edition) indicate an apparently effective toxicity for mosquito larvae in phenomenally high dilutions. Others have reported similar results. It is true, however, that when administered in sufficient quantities DDT is a poison, just as are all other insecticide materials.

Irresponsible publicity concerning the insecticide possibilities of DDT has too often lacked proper scientific reservation; and, as a result, popular interest has acquired an urgence far outrunning the seemingly plodding, step-by-step advance permitted by scientific caution. Normal scientific caution is indispensable to the sound advance of scientific knowledge; but it is just as important to avoid unwarranted, delaying overapprehensiveness such as a misinterpretation of the papers cited seems here and there to have engendered, as it is important to avoid heedless overenthusiasm and the errors and resulting hazards to which that may lead.

The three admirable papers in question are based upon thoroughly scientific studies, the chief objectives of which, however, appear to have been concerned with the pharmacological properties of DDT as a drug or poison when administered to laboratory animals in relatively heavy doses; with changes in the tissues and organs by which DDT poisoning may be recognized; and with the development of techniquues for identifying the presence of the chemical in cases of DDT poisoning, and for measuring the quantities of the chemical in the organs and tissues in such cases.

A detailed review of these (for their own special field) important papers would be interesting and much worth while in its proper place; but for MOSQUITO NEWS it is sufficient to consider their validity as a basis for alarm concerning the health hazards (if any) which may attend the normal use of DDT as an insecticide.

The technical description given in these papers of the damage to organs and tissues which may result from poisoning by massive doses of DDT do have a gruesome connotation for the layman; but before we translate them directly into hazards which may attend the use of DDT as an insecticide, we should carefully take stock of the problem as a whole.

The doses administered were on the order of 50 to 1500 milligrams per kilogram of body weight for the animals used. Translated into everyday language, these doses would be approximately comparable to doses ranging from a rounded teaspoonful (about one-sixth of an ounce) to more than a quarter of a pound for a 200-pound man. In the experiments described, the DDT was administered in several ways.

With one series of animals (rats), DDT was injected directly into the abdominal cavity of each experimental animal as a single dose, in a quantity that would be equivalent to *more than a quarter of a pound* of the chemical introduced into the abdominal cavity of a 200-pound man.

When these animals were killed and examined at the end of 6 days, the "Significant Pathological Changes" reported for the three animals were: "Slight, slight to moderate, and moderate to marked central necrosis, and slight hydropic degeneration of the liver, slight focal necrosis of leg muscles, and slight focal ulceration of gastric mucosa."

With another series of experimental animals (rabbits) DDT was administered by mouth daily until the animal died or was near death, in quantities (50 milligrams per kilogram of body weight) equivalent to a rounded teaspoonful (one sixth of an ounce) daily for a 200-pound man. The animals lived 15, 18, 23, and 25 days. The total amount of DDT necessary to cause death when administered in this manner being respectively equivalent to 10 ounces, 12 ounces, 15 ounces, and 18 ounces for a 200-pound man. The damage found on post mortem examination was reported respectively as: "Liver necrosis," "Coagulation necrosis of the liver," and "Coagulation necrosis and hyaline degeneration of the liver."

Obviously, the quantities used have little practical relation to the relatively infinitestimal intake that might be involved where DDT is used properly as an insecticide.

Another source of alarm concerning the health hazard which might attend the use of DDT as an insecticide, which has likewise been cited, appears to be the report that DDT is toxic for fish at a dilution of one part in ten million parts of water (1 to 10,000,000).

This, however, is not necessarily an index to any potential health hazard when used as an insecticide.

Cresylic acid is a standard ingredient in sheep and cattle dips, and in repellent fly sprays designed for use about dairy barns and the like; yet M. M. Ellis reports that cresylic

acid at a dilution of 1 to 10,000,000 killed goldfish in 5 days, and at a dilution of 1 to 1,000,000 in 6 to 24 hours.

Also, *chloramine* is used in large quantities in the treatment of city water supplies; yet Coventry, Shelford and Miller report that chloramine at a dilution of 1 to 3,000,000 killed trout fry at once, and at a dilution of 1 to 16,000,000 in 48 hours; and that it killed sunfish and bullheads at a dilution of 1 to 2,500,000.

Many thousands of men have been using a 10 per cent DDT louse powder dusted inside their clothes. It would be strange if, when used in this manner, appreciable quantities of DDT should not be either inhaled, or taken internally with food, the occasional contamination of which by DDT could scarcely be avoided. We should know by now if any ill effects are likely to result from this relatively heavy external application of DDT and from its probable occasional attendant intake.

Much work still remains to be done, of course, before we know just where and how DDT may be best and most safely used; but the writer can remember the similar reaction to the possible horrors which might result from the "indiscriminate" use of Derris when it was being introduced some twenty odd years ago. One of the leading importers and millers of pyrethrum then told me substantially "We won't touch it! The health hazard for our employees is too great; and we can't take the chance of suits for damages which might be filed by users of the stuff."

DDT seems to have immense promise as an insecticide. We should keep our feet on the ground, and strive to avoid any delaying over-apprehensiveness, quite as much as any over-enthusiasm until we learn how best to use it. With DDT, as with other insecticide poisons, our real problem is to find the ranges within which it may be used with safety, or how to use it and at the same time exclude it from that part of the protected product which will eventually be consumed.

It seems doubtful whether any health hazard to the operator would attend the use of DDT as a Culicide; and in the quantities required, whether it would constitute a hazard for livestock.

MORE DDT FINDINGS. NEW INSECTIDE IS APPARENTLY SAFE TO USE WHEN DUSTED DRY ON THE SKIN AND WHEN BREATHED IN AIR INTO WHICH IT HAS BEEN SPRAYED, RESULTS OF TWO SERIES OF EXPERIMENTS SHOW. Anonymous. Science News Letter for Nov. 11, 1914, p. 310.

Since the preceding special review of three articles in "Public Health Reports" was written, the article cited here has appeared. It seems that Dr. Paul A. Neal of the National Institute of Health, and Dr. Herbert O. Calvery of the U. S. Food and Drug Administration, the latter a joint author of one of the three papers reviewed above, had recently reported "before an audience of entomologists in Washington," "results of — experiments supporting" the conclusion set forth in the subtitle of this item in "Science News Letter."

Dr. Calvery's summation is quoted as: "In solid form DDT applied topically to the skin is nonirritating, nonsensitizing and not appreciably absorbed. In solution, either in oil or in organic solvent, it does readily penetrate the skin, is very mildly irritating and a very mild sensitizing agents."

Dr. Neal is reported as having "corroborated his colleague's verdict so far as safety in use as a dry delousing powder is concerned, and added that the spray or aerosol solutions containing 1 per cent of DDT were breathed for long periods by rabbits without any tangible ill effects."

Dr. Neal is directly quoted as having added: "In a clinical and laboratory study of three men who had had several months' continuous occupational exposure to DDT in its various forms as an insecticide, an evaluation of the results failed to indicate any definite toxic effects."

This item, based as indicated upon results apparently still unpublished, seems to bear out the point of view outlined in the foregoing review. It should be repeated, however, that

DDT probably should never be applied to products like cauliflower, broccoli, lettuce, celery and the like from which residues can not be removed before consumption, nor to other products likely to carry an appreciable residue until it can be fully established by the agencies referred to, what limit of tolerance for such residues may be entirely safe. But any probable use of DDT for the control of mosquitoes appears unlikely to carry any hazard for the operator; and, as with pyrethrum, ways will doubtless soon be found to increase materially the present rather narrow margin between the upper limit of its effectiveness as a mosquito larvicide and the limit beyond which it is no longer toxic for fish. R. D. G.

A CRITICAL REVIEW OF THE LITERATURE RELATING TO THE FLIGHT AND DISPERSION HABITS OF ANOPHELINE MOSQUITOES. By Don E. Eyled. Division of Infectious Diseases, National Institute of Health, U. S. Public Health Service, Bulletin No. 287 (1944), 39 pp.

Study of flight habits is of paramount importance. Inflexible limits have too often been set. In this country a 1-mile limit is most often set as a radius for operations against *A. quadrimaculatus*. This limit has usually given good results; but it has been shown on several occasions that this mosquito can fly greater distances.

The following factors may cause excessive dispersal: 1. Prolific breeding outside the set limits of control. 2. Absence of adequate blood sources nearer the breeding places than are afforded within the protected area. 3. Winds favorable to dispersion. 4. Artificial means of dispersal, such as carriages, automobiles, trains, ships, airplanes and the like. Such passive transportation for more than 100 miles has been recorded, and it is supposed that *A. gambiae* was thus introduced into Brazil.

Marking techniques used by various investigators are discussed, and comprise: 1. Liberating adults which had been sprayed with aqueous solutions of aniline dyes. 2. Dusting mosquitoes to be liberated with dry powdered aniline dyes. 3. Dusting with metallic bronzing powders. Methods of recognition when captured are adapted to the marking technique employed.

Annotated lists of species review the work of various investigators, and a tabular summary, brings together in compact form the data available on the flight range of the important anopheline vectors.

A very comprehensive bibliography of work in this field is given.

DENGUE FEVER EPIDEMIC. Anonymous. The Hawaii Health Messenger, Volume IV, August, 1944: 2-3.

This article gives a very full account of measures taken and progress attained in suppressing the recent epidemic of dengue fever in Hawaii. "Two commercial airline pilots arrived in Honolulu on July 19, 1943, one in the fourth day after onset, the other apparently ill with dengue in the incubation stage." These cases were hospitalized: the first at once, the second on the fifth day after onset. An August 5th, and subsequently, cases began to appear in the Waikiki district.

There was a previous widespread epidemic of dengue in the Hawaiian Islands in 1903, and a lesser outbreak in 1912. "The vectors of dengue in the Hawaiian Islands are: *Aedes aegypti* Linnaeus, which breeds in artificial containers such as bottles, tin cans and tanks, and *Aedes allopictus* Skuse, which breeds in artificial containers, and also in natural containers, such as tree and rock holes, and water holding plants.

The Public Health and Military Authorities at once began a vigorous campaign to prevent an explosive epidemic. Inspectors of the Rat and Mosquito Control Squad of the Honolulu Chamber of Commerce were immediately augmented by many additional new inspectors, including military personnel.

Extensive *Aedes* mosquito control work was undertaken, including a campaign for public cooperation, stimulated by newspaper publicity and the distribution of printed information and instructions.

Most areas responded well; but one large business firm in the Kakaako District failed

to cooperate, with the result that as many as 70 employees of this firm were incapacitated by dengue at one time, and a total of 400 cases were reported from that district.

Many interesting details of the campaign are given in this report, and in the "Health Report" in another column it is stated: "At the end of July (1944) the *Aedes* breeding index for Honolulu was 0.7 per cent, which is the lowest index reported for the city since the start of the program."

After the first year, it became evident that the dengue problem might become Territory-wide, not because of the local situation, but due to increasing importation of dengue cases from the Southwest Pacific. The logical solution has been to extend *Aedes* mosquito control immediately to all areas where necessary for protection of the war effort. R. D. G.

ENTOMOLOGICAL PHASES OF THE RECENT DENGUE EPIDEMIC IN HONOLULU. By Robert L. Usinger, Passed Assistant Sanitarian (R), U. S. Public Health Service. Public Health Reports, 59 (1944): 423-430.

This article and the reprot on the same epidemic, published in Hawaii Health Messenger for August, 1944, Volume IV, No. 2, should be considered together by anyone interested in this mosquito borne disease.

Hawaii was mosquito free until 1826, when the arrival of *Aedes* (*Culex*) *quinquefasciatus* (Say) was definitely recorded. *Aedes aegypti* (Linn.) arrived later, and was abundant and widespread in 1892. At that time, *Aedes allopictus* (Skuse) had not been reported in collections; whereas it was reported "very numerous and conspicuous" in 1902. Only these three species are known to occur in Hawaii, where no species of *Anopheles* has yet become established.

The author states that the outbreak is of doubtful origin; but repeats the current story of the two commercial flyers introducting the infection from the Fiji Islands, where an epidemic was in progress. The disease was fairly typical, but less severe than in some epidemics. The three mosquito species are discussed at some length, with special reference to their habits, distribution, and relative abundance in Hawaii. Very curiously, the numbers of cases were in nearly inverse proportion to the general mosquito breeding index. This apparent anomaly is analyzed and tentatively explained. Dengue epidemics may be ended in three ways: 1. When frost occurs, this may kill adult mosquitoes and stop the epidemic. 2. When most of the population has had the disease and has acquired immunity. 3. The epidemic will disappear when the mosquito carriers are reduced in numbers below the threshold of sanitary importance. It was important for military reasons that a general epidemic involving the whole population be avoided; so the third, and physically most difficult, course has been employed in the present epidemic. R. D. G.

ANOPHELES MOSQUITO SURVEY IN CANADA. By C. R. Twinn, Dominion Department of Agriculture, Ottawa, Division of Entomology, Science Service, Contribution No. 11 (Multilith), June 20, 1944, 13 pp.

This neatly reproduced and well illustrated little pamphlet, of which a copy has just come to the editor's desk, is designed to reassure those of whom it is said: "Some concern has been expressed regarding the possible danger of malaria transmission occurring in Canada as a result of the presence in this country of prisoners of war and the return of members of the armed forces from war theatres where this disease is prevalent." It is pointed out that, while a few species of *Anopheles* mosquitoes "are rather widely distributed in Canada, they are not generally abundant, and represent only a small percentage of the mosquito population except, perhaps, in restricted localities."

Brief descriptions, tables and figures provide a guide to the life histories, habits and identification of the Canadian Anophelines, with directions for their detection, collection, and study, and for enlisting official assistance in the appraisal of any potential local malaria hazard. R. D. G.

Anopheles gambiae in Brazil, 1930 to 1940. By F. L. Soper and D. Bruce Wilson. pp. xviii 262. 75 figs., 49 tables. The Rockefeller Foundation, 1943.

The eradication of *Anopheles gambiae* Giles from Brazil is one of the great achievements of mankind in the prevention of disease. *Anopheles gambiae* was first discovered "in a small over-flowed grassy field" near Natal, Brazil, in March 1930. It probably arrived several months before by boat from Dakar, West Africa. Two explosive outbreaks of malaria occurred in Natal during 1930 and 1931 and stimulated a local control program. Thereafter the situation was quiescent for seven years, during which time *gambiae* became firmly entrenched and slowly spread through relatively unfavorable territory. Then, in 1938, *gambiae* invaded the river valleys of the States of Ceara and Rio Grande do Norte. The Assu, Apodi, and Jaguaribe river valleys "were the scene of epidemic malaria equal in severity, if not in extent, to that of the worst outbreaks described in the literature of this disease . . . Entire families were laid low at one time. Often none were spared to cook the little food available or to seek more; none were able to go for medicine, even had there been money with which to buy it . . . Not only was everyone ill, but the mortality was appalling."

To cope with this situation, the Malaria Service of the Northeast was organized, drawing heavily on personnel from the highly effective Yellow Fever Service and supported by the Ministry of Health of Brazil and the International Health Division of the Rockefeller Foundation. It was decided to attempt complete eradication since *gambiae* is probably the most domestic of all anophelines and breeds most effectively in small shallow, sunlit pools of fresh water without vegetation.

The control program was based to a large extent on paris green applied wet or dry. It was applied in dry form by mixing "approximately one kilogram of dry earth, dust, or fine gravel with ten grams of paris green and then repeating the operation until 5 kilograms had been mixed." In most of the work this mixture was dispersed by hand but chronic arsenic poisoning was a serious disadvantage to this method of application. In this connection it is reported that "an overzealous inspector, who eventually recovered, suffered severely from a public demonstration of the nontoxicity of paris green in which he added a goodly portion of it to his beer."

Great emphasis was placed on adult control measures or "disinsectization," although the authors "secured ample proof that anti-larval work (paris green) alone is able to eliminate *gambiae*, whereas anti-imaginal measures alone were never shown to be effective." As in the South American *aegypti* eradication program, the adult survey method proved to be the most sensitive and was indispensable in the final stages of eradication.

Three significant points emerge out of the *gambiae* situation in Brazil. First, the incidence and severity of malaria in a region depends very largely upon the habits of the vector, the domesticated *gambiae* causing a catastrophic epidemic in an area where local anophelines had supported endemic malaria at a low level for centuries. Second, mosquito control measures have now been perfected to a point where spectacular results may be achieved by concentrating on the objective. Third, the danger of importing foreign vectors is a very real one and must be squarely faced by a civilization on the threshold of an era of international air transport.—(From Monthly Report, March, 1944, Office of Malaria Control in War Areas, Atlanta, Ga.) R. L. Usinger, P.A. Sanitarian (R).

Insect Repellent Composition Patented. U. S. Patent 2,356,801, issued August 29, 1944, to Bernard V. Travis and Howard A. Jones, Orlando, Florida, assignors to the United States of America as represented by Claude R. Wickard, Secretary of Agriculture, and his successors in office.

This invention relates to an improved insect repellent composition. The materials comprising this composition are dimethyl phthalate 60 per cent, 2-ethyl-1, 3-hexanediol 20 per

cent, and n-Butyl mesityl oxide oxalate 20 per cent. In more familiar terms, this is three parts of dimethyl phthalate, to one part of Rutgers 612, and one part of Indalone.

The relative effectiveness of this 60-20-20 mixture in comparison with each of these now well known repellents used alone, are given in tabular form as follows:

EFFECTIVENESS AS MEASURED BY THE AVERAGE REPELLENT TIME IN MINUTES

SPECIES AND TYPE OF TEST	DIMETHYL PHTHALATE	2-ETHYL-1, 3-HEXANEDIOL	N-BUTYL MESITYL OXIDE OXALATE	60-20-20 MIXTURE
Anopheles quadrimaculatus (laboratory)	206	78	30	257
Aedes aegypti (laboratory)	234	363	160	321
Aedes taeniorhynchus (field)	153	276	164	212
Stomoxys calcitrans (laboratory)	47	101	171	189

The unusual increase in repellent time obtained by combining the three components appears to result from a synergistic effect, whereby one increases the repellent effect of another.

This insect repellent composition may cause a slight, temporary stinging sensation when applied undiluted to the more sensitive areas of the skin; but extensive tests over long periods of time have shown it to be toxicologically safe for repeated application to the human skin. R. D. G.

ANNOUNCEMENTS

ANNUAL MEETING, AMERICAN MOSQUITO CONTROL ASSOCIATION. The 1945 Annual Business Meeting will be held at the Hotel Claridge, Atlantic City, N. J. on the evening of March 29, 1945. Details will be sent to the membership by mail, previous to the meeting. T.D.M.

NEW JERSEY MOSQUITO EXTERMINATION ASSOCIATION. The 1945 Annual Meeting will be held at the Hotel Claridge, Atlantic City, N. J. on March 28, 29, and 30, 1945.

Proceedings of the thirty-first annual meeting (1944) are now available on order from the Secretary of the N. J. Association. See review by Sam Reck in this number of MOSQUITO NEWS. T. D. MULHERN.

WANTED

BACK NUMBERS OF MOSQUITO NEWS WANTED. In order to complete sets of back numbers of MOSQUITO NEWS for sale to libraries, etc., the Secretary needs copies of the following numbers: Volume 1, No. 1 and 2 (combined), and Volume 3, No. 1. If you have copies that you do not need, please send them to the Secretary, who will pay for them at the regular price of seventy-five (75¢) cents per copy. T.D.M.

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